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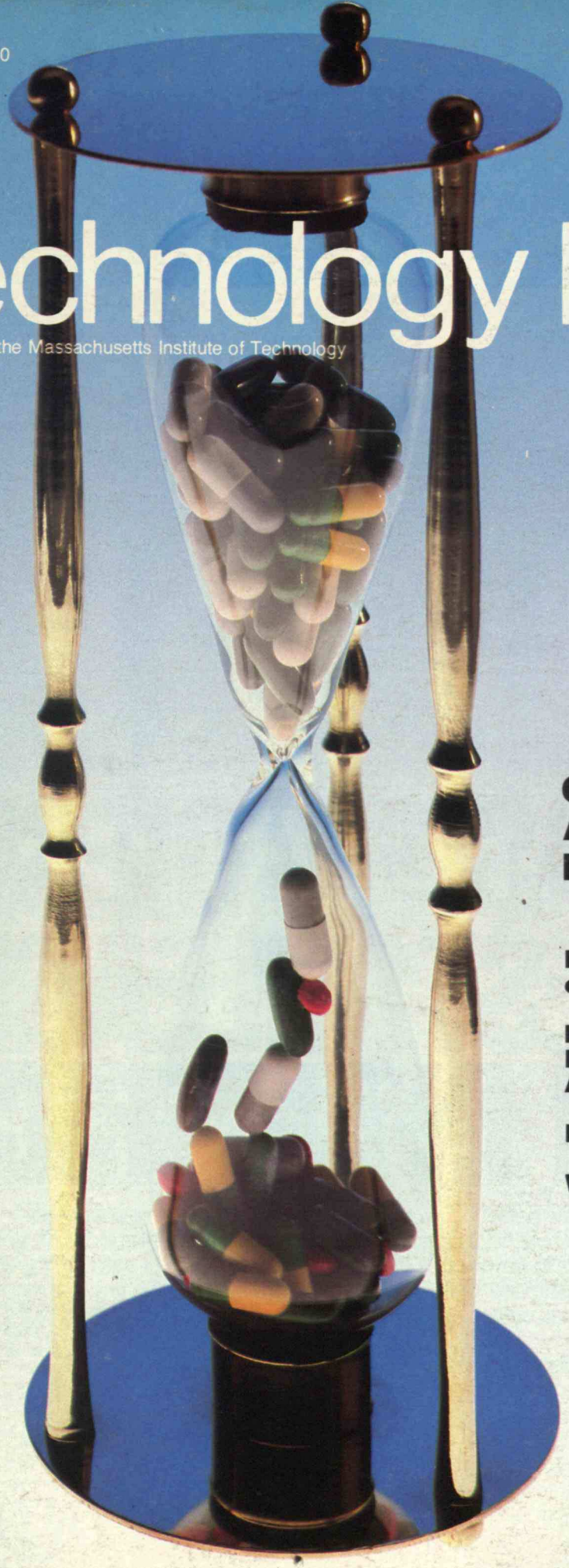

Controlled Release: A New Approach to Drug Delivery

Roger Fisher and Paul Warnke on Gaining a Nuclear Peace

Human-Powered Flight: Building the "Gossamer Albatross"

Burying Radioactive Waste

What Matters in Management

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Edited at the Massachusetts Institute of Technology
Volume 83, Number 5
April 1981

Technology Review

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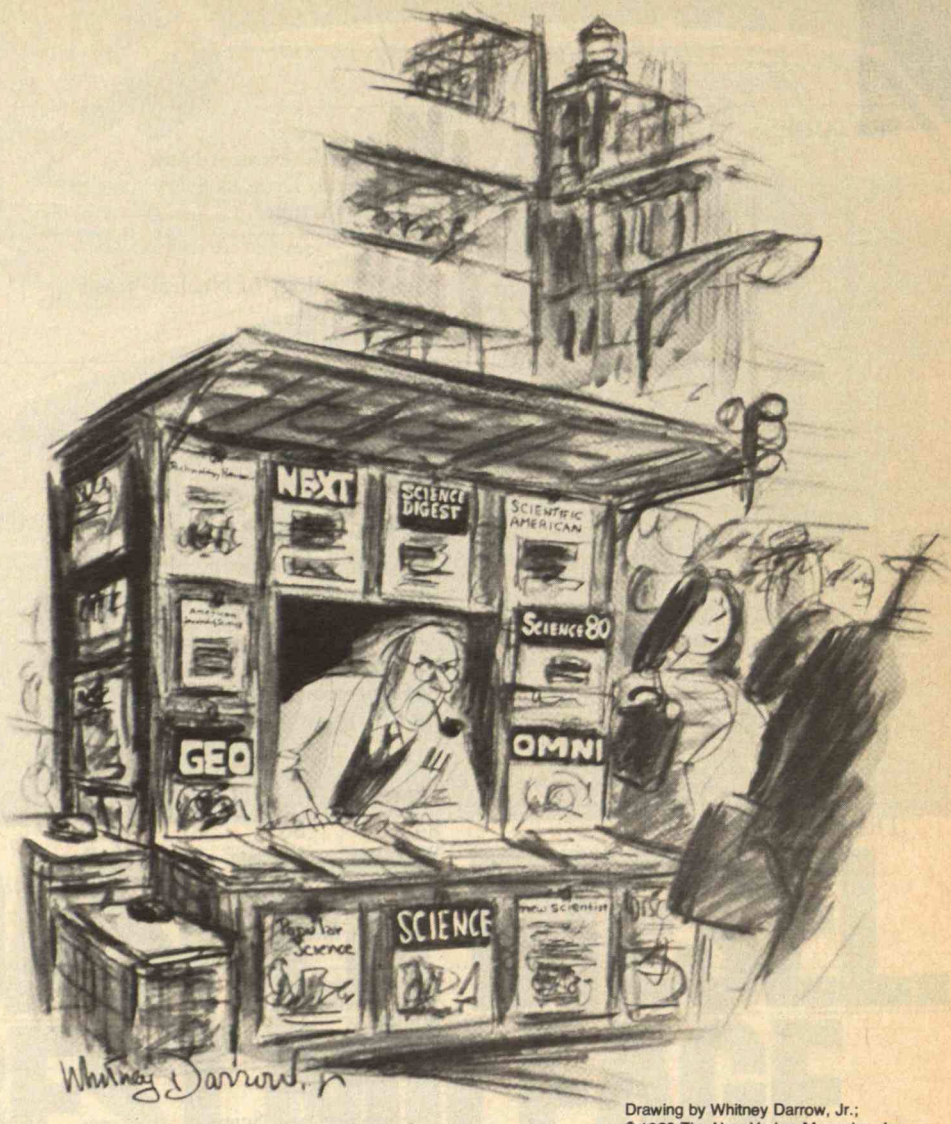


Drawing by Whitney Darrow, Jr.;
© 1980 The New Yorker Magazine, Inc.

Science for People

For reasons that are obvious when you study the upper left corner of the newsstand (*above*), the editors of *Technology Review* rejoice in the recent comment by Whitney Darrow, Jr., on the plethora of magazines about science. Though we are one of the oldest (1899) in the company, we are perhaps its smallest member (70,000 circulation), and it's nice to be included.

But we think a postscript is in order, because *Technology Review* occupies a very special place in the astonishing recent proliferation that Mr. Darrow chronicles. For the *Review* is a magazine not of science but of technology — of science in the context of its service to people.

Our readers — already informed far more than most Americans about science and engineering — share with us an understanding that technology is never value-free. The profound changes wrought by science and engineering during the years since this magazine was founded brought both power and problems, creating an immensely complex world of which our understanding is still inadequate. Our special goal is to help our readers assess the role of technology in that world: how its benefits can be better realized and its risks diminished; what its achievements and their effects may be; and how we can see that the promises of science and engineering are realized for more and more of us in a future world of diminished physical but vastly enlarged intellectual resources.

An ambitious target, and comments on our progress toward it are always welcome. — *J.M.*

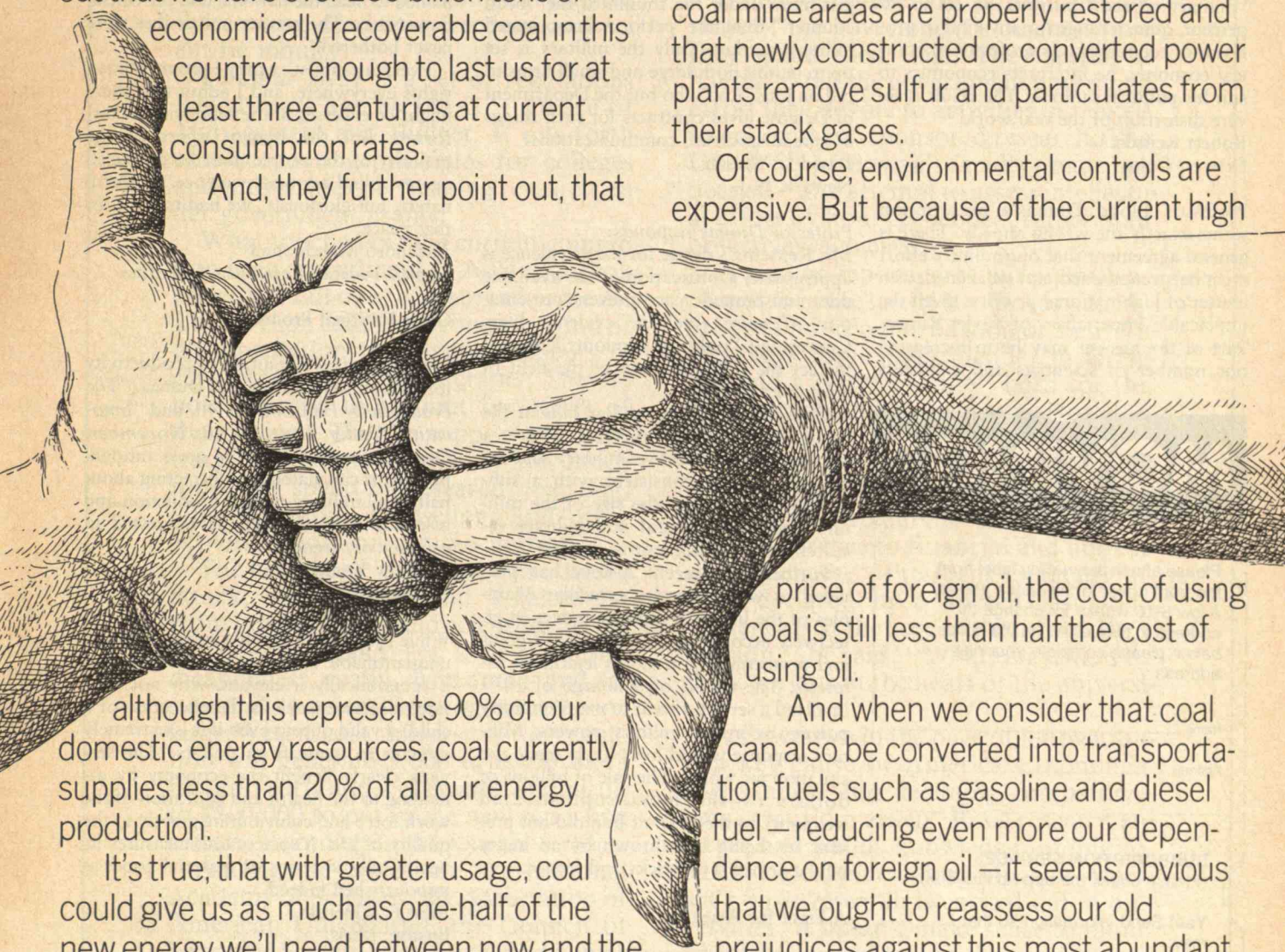
Some insist coal is good. Some insist coal is bad.
We insist it's not that black or white.

Those who insist that coal is good point out that we have over 200 billion tons of economically recoverable coal in this country—enough to last us for at least three centuries at current consumption rates.

And, they further point out, that although this represents 90% of our domestic energy resources, coal currently supplies less than 20% of all our energy production.

It's true, that with greater usage, coal could give us as much as one-half of the new energy we'll need between now and the year 2000—enough to help loosen the dangerous ties that bind us to expensive and insecure foreign oil.

But those who insist that coal is bad point to abandoned mines which scar the landscape and allow acid water to seep into streams.



And to the fact that coal contains ash and sulfur which, if not removed, can pollute the air when burned.

Still, we believe that these days the advantages of coal outweigh its disadvantages.

Because these days we have extremely tough environmental laws.

Laws that require the restoration of mined lands and the protection of air and water resources. Laws that ensure that coal mine areas are properly restored and that newly constructed or converted power plants remove sulfur and particulates from their stack gases.

Of course, environmental controls are expensive. But because of the current high price of foreign oil, the cost of using coal is still less than half the cost of using oil.

And when we consider that coal can also be converted into transportation fuels such as gasoline and diesel fuel—reducing even more our dependence on foreign oil—it seems obvious that we ought to reassess our old prejudices against this most abundant of all fossil fuels.

At least Atlantic Richfield thinks so.

There are no easy answers.

ARCO

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Dollars and Sense of Defense

Lloyd Dumas's obvious dislike for military research in "Innovation Under Siege" (*November/December, p. 8*) leads to simplistic solutions for inflation (military research has reduced innovation, resulting in unemployment and inflation). His only hard number is a range of spending for "military-related" pursuits of 30 to 50 percent, quite a range for any kind of professor of economics. As professor of political economy, he interprets economics to suit his political outlook. The result is severe distortion of the real world.
Robert Reitsema
Denver, Colo.

Professor Lloyd Dumas's prescription seems exactly the wrong remedy. There is general agreement that our military effort must be strengthened, not weakened, as a matter of high national priority, given the implacable imperialism of Soviet Russia. Part of the answer may lie in increasing our number of scientists and engineers and discrediting the negativism of the media and many academics toward science, technology, and military preparedness.
David Herron
Atherton, Calif.

Having been a military contractor for 23 years, I find that the cost limitations of commercial markets place the technologist more under the thumb of the "bean counter" than the performance-oriented military market. Only the military is set up to permit both large and small firms to bid on jobs. And who but the Department of Defense gives contracts for such things as spread-spectrum communications?
David L. Wiesen
Newark, N.J.

Professor Dumas responds:
Mr. Reitsema's desire for hard evidence is appropriate. Obfuscation of the available data and limited space prevent presentation of more extensive evidence here. Concerning "political economy," that is in fact the original name of the field of economics.

One does not shoot dollar bills at the enemy. It is perfectly possible to have a stronger, more effective military and increased security consistent with a substantial reduction in the size of the military budget in general and military research and development in particular.

Furthermore, recent history has provided us with several spectacular examples of the limits of military power in effectively accomplishing the nation's goals and protecting the nation's legitimate interests. The OPEC oil embargo of 1973 involved a serious threat to major military powers by minor military powers. Military response would have likely made the situation far worse. The sale of billions of dollars of the most sophisticated weaponry to the shah of Iran did not prevent his being overthrown by an angry public armed with sticks and stones.

A Fight for Peace

I was amazed and shocked to read "Scientists and Human Rights" by E. Callen, Bernard Cooper, and John Parmentola (*December/January 1980, p. 21*). The authors know nothing about the present situation in South America; they have been misbriefed (probably intentionally). As a member of the academic community of Argentina, I know that it is still alive and somehow stronger than before the military crushed the Communist terrorist gangs. The scientists that left the country were accomplices to the terrorists who wanted to destroy the roots of Argentina: Catholicism and liberty. It is untrue that universities are run by military officers. The military ran them briefly for a couple of months following the coup in 1976, and then distinguished civilians were named to head the national and provincial universities. The private universities were never bothered.

Everyone must worry about human rights everywhere, and I admit that there might be excesses in the repression of terrorism. But the human rights of the majority of the people must be protected against blind terrorist violence. Unfortunately, but gloriously, we had to fight for that peace.
Alejandro Marchionna
Capital Federal, Republica Argentina

Gross Rational Product

I propose a new definition of productivity for economists Thurow and Dumas (*"The Productivity Problem," p. 40,* and *"Innovation Under Seige," p. 8, November/December*): the GRP. The gross rational product is calculated by subtracting about half of all military-related production and research. I would then be interested in productivity trends.
Geoffrey Young
Amherst, Mass.

While Professor Thurow suggests that the unquantifiable output of the service sector is economically irrelevant, why not consider a service (such as the education of a child) a valid output even if it is extremely difficult to quantify in dollars? The services clearly benefit the economy by attending to the health and education of the work force and contributing greatly to the quality of life. A society that measures its health only in terms of material goods is impoverished indeed.
Alan F. d'Heurle
Boston, Mass.

Progress with Waste

In contrast to Professor Bupp's subjective observations in "The French Nuclear Harvest" (*November/December, p. 30*), the fact of solid progress is evident. Professor Bupp is principally concerned with "breeder reactor" progress at the French

Continued on page 24

Furor Over a Non-Vitamin

A-21, it's called. When he first heard about it, Yale's president A. Bartlett Giamatti thought it was a vitamin. It has aroused high ire among scientists and educators, in a ruckus pitting academe against government bureaucracy. The controversy illuminates how Washington's tentacles are spreading on campus, threatening academic freedom and scientific inquiry.

Circular A-21 is a set of regulations issued years ago by the U.S. Office of Management and Budget. It sets forth cost accounting principles for colleges and universities performing research under government grants.

What touched off the current commotion is an amendment to A-21 that took effect last fall over widespread protests. The revision calls for an onerous kind of documentation by faculty members receiving federal research grants. They're now required to account for 100% of their doings. They're supposed to keep track of and report precisely how much time they spend on research, teaching, administration, counseling, and other activities, both on campus and off.

The new tangle of red tape has drawn attack, individually and collectively, from academicians and scientists across the country. They see it as wasteful, meaningless, costly, demeaning, and detrimental to scientific progress. At one large West Coast university, the regulation will generate 3,000 to 8,000 more reports yearly and will mean spending up to $300,000 to put in the new reporting system, according to the journal *Science.*

Among the critics are the National Academy of Sciences, the Association of American Universities, the Council of Scientific Society Presidents, and numerous faculty senates. The academy takes the view that the regulation will churn up a mountain of "cumbersome and meaningless" paperwork, stifle flexibility in research, and frustrate and demoralize faculty members. Educational institutions, already hard pressed financially, will now be forced to spend large sums in ways that contribute nothing to education and science.

Individual professors protest that it's none of the government's business how they spend their time. They seethe at having to tell the government how much effort they devote to activities unrelated to government-sponsored research. The University of Hawaii's faculty senate has decried "any attempt to assess intellectual effort by hours expended, rather than objectives achieved. . ."

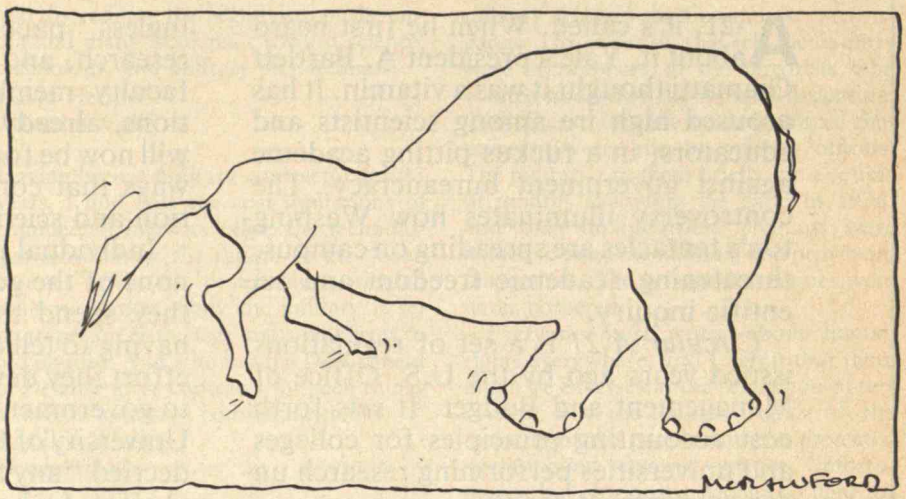
A similar reporting requirement was proposed in the late 1960s. It was quickly dropped on recommendation of a government task force that called it "meaningless and a waste of time" both for the government and universities. Now it's back again.

"Never have I seen the lash of federal regulation applied to a crucial area of the nation's intellectual life with such seeming indifference to financial and human consequences," President Giamatti of Yale declared in a speech last fall. "Science is at the core of the university's mission," he said. "Whatever strikes at that core cuts at the heart of the university."

A slowdown in the pace of innovation is a key cause of America's economic sluggishness and declining competitiveness in world markets. Basic research enlarges and builds knowledge leading to technological innovation. Much of America's basic research is carried out in universities. It doesn't make sense to blunt scientific creativity, inquiry, and experimentation on campus through still more layers of red tape that serve only to keep paper-shuffling bureaucrats busy.

The Political Paradox

Kenneth E. Boulding is a program director at the Institute of Behavioral Science and distinguished professor emeritus of economics at the University of Colorado at Boulder.



Michael Crawford

THE recent election produced a fair amount of table talk and columnar oration about conservatism and the so-called swing to the right. I have always felt that the right and left were quite inadequate dimensions to describe my own political heresies, which are always labeled on an up and down scale (I being up and those who disagree, down).

I wish I knew the history of the right-left metaphor. In a world that is predominately right-handed, only conservatives could have identified conservatism with what is right and radicalism with what is left after you have taken away what is right. It always surprised me that the left was willing to accept the title. An even odder term is "southpaw," for a left-handed baseball player, which presumably means that a right-handed baseball player is a northpaw. The North tends to look down on the South as impoverished and lazy, but southpaws seem to have a kind of sneaky advantage. This may rub off on the political left.

My father was a Gladstonian Liberal and I remember him making quite a speech about how only liberals did anything good. When I first came to the United States, I found it even more confusing to identify the Southern Democrats as liberals and the LaFollette Republicans as conservatives. If the stability of democracy is a function of the inability of society to arrange its quarrels neatly, we are still in fairly good shape.

Unlikely Hawks, Accidental Doves

When looking at what people actually do, and even more at what actually happens —which often bears very little relation to what people do and still less to what they say — the paradoxes become even stronger. Conservatives are supposed to favor the rich and the business class; these are the people who have a lot to be conservative about. Liberals, and still more, radicals, are supposed to favor the poor and the working class. However, the last time there was much shift in the distribution of income in the United States toward the poorer end of the spectrum was under Calvin Coolidge, which he may not have intended, as it is rather doubtful he intended anything. Indeed, sometimes doing nothing is the most radical thing to do. Under Herbert Hoover, profits became sharply negative, and under Franklin Roosevelt they rose sharply from 1932 to 1942 in spite of — or who knows, because of — the New Deal. Lyndon Johnson's War Against Poverty produced remarkably little change in the distribution of income, and President Nixon's stillborn welfare proposals could well have been more radical in actually changing the distribution of income than anything the Democrats ever dared to conceive.

Conservatives are supposed to be saber rattling and jingoistic, while liberals are supposed to be peaceable, though radicals have a reputation for being rather selective about who they want to be peaceable with. In the last hundred years, however, the only war declared by a Republican president was the Spanish-American War. The First and Second World Wars, the Korean War, and the Vietnam War are sharply associated with Democratic presidents. It was the Republican Eisenhower who produced détente with the Russians and the Republican Nixon who produced détente with China. Even Teddy Roosevelt, who was sort of Republican, carried the big stick more often than he used it.

The class structure of political parties is even more confusing. There is some tendency for conservative parties to be parties of the rich and the poor against the middle, and for liberal parties to be parties of the middle or maybe lower middle. The rise of the Labour party in England might seem to contradict this rule, but it was more a party of the organized working class rising to the lower middle then a party of the poor. Indeed, it may well have been the failure of the old Liberal party to realize that trade unions had become middle class as well as nonconformist that led to its decline and replacement by the Labour party, which had to take in an aristocratic fringe of intellectuals before it could really rise to power. Indeed, I cannot think of any party of the poor, simply because the poor are generally too poor to have parties. The really poor in all societies are too busy keeping body and soul together to bother much about luxuries like politics, so they tend to be either disfranchised or occasionally mobilized by charismatic leaders from the middle class.

A Political Peter Principle

Certainly Communist parties, for all their rhetoric, have never been parties of the poor or even the real working class. They tend to be parties of the somewhat alienated middle class out to displace the aristocrats and the mandarins and take their place. All communist revolutions seem to have produced a new class of "apparatchiks" and bureaucrats who enjoy many of the perquisites of the capitalist rich, some with a great deal more power than any Rockefeller. The Cultural Revolution in China and the catastrophe in Cambodia amply illustrate the instability, indeed almost the impossibility, of a society based on radical

egalitarianism and class war. The poor cannot win a class war; after they have won it, there is nothing left to win.

Perhaps this is why the left, whether old or new or even liberal or radical, seems to be taking the heralded worldwide swing toward conservativism with remarkable calm. Perhaps there is a rising awareness of what I call the "law of political irony": that everything we do to help people hurts them, that everything we do to hurt people helps them, indeed that almost everything that happens is apt to be the opposite of what we intend. Perhaps the most important distinction is not between conservatives and liberals but between those that know what they want and those who know only what they don't want. There has been some tendency to identify those who know what they want with conservatives and those who know what they don't want with liberals or even more with radicals, and this connection has been the undoing of virtually all the more radical movements.

Perhaps this is why revolutions are so disappointing and tend to produce the very things that they revolted against. Lenin was the czar; Stalin was Ivan the Terrible. The Apparatchiks are employers without even the checks and the balances of a capitalist market. The Gosplan is a corporation beyond the dreams of General Motors. Maoism, and still more its corrupted form in the Gang of Four, is a society in which the equivalent of Madison Avenue has a total monopoly on persuasion. Even the American Revolution produced essentially a monarchical society in the United States — what is the American president but a nonhereditary George III? — whereas the British countries developed republican societies under constitutional monarchs!

It would be nice to believe that the world shift toward conservatism represents the realization that it is better to be for the inadequate than merely against something in a fruitless dialectic. However, this is probably too optimistic. Conservatives make their own set of mistakes; they may know what they want, but they often want the wrong things. They tend to develop an insensitivity to the very forces that elect them and invite eventual defeat. Still, one wonders whether, underneath the winds of ideology and even the storms of human misery, something is growing — call it political competence. This would be a true greening of the human landscape. □

Searching for Life's Origins

Robert C. Cowen is science editor of the Christian Science Monitor *and former president of the National Association of Science Writers. He holds S.B. and S.M. degrees in meteorology from M.I.T.*

SCIENCE historian Owen Gingerich has an intriguing recipe for a subject with surefire appeal. Take equal parts of the romance of space and the mystery of the past, mix well, and spin your story. He was thinking of archaeoastronomy, but the comment applies equally well to the origin of life. And that subject entered the 1980s with a promise of many a good yarn to come.

Scientists are having to rethink some of their assumptions. The notion that Earth's primitive atmosphere was rich in methane and ammonia, partly because such a reducing environment was handy for making "prebiotic" chemicals in "primitive Earth" experiments, doesn't seem to fit what geochemists take to be the facts. The atmosphere wasn't all that reducing, they say.

Equally important, it is becoming harder to squeeze an evolutionary scenario into the ever-shrinking time span before signs of life appear in the geologic record. The earliest evidence — although controversial — now dates to about 3.8 billion years ago, while the age of the planet itself is only 4.6 billion years. To add to the fun, the outrageous suggestion that comets may have seeded Earth with life or its precursors continues to demand attention.

Although the subject of evolution has ancient roots, its dominant theme for the past three decades was set by the late Harold Urey who, in the 1950s, sketched a plausible scenario for the rise of life on a primitive Earth. He predicted that energy sources such as solar ultraviolet or lightning should form such interesting prebiotics as amino acids in a methane-ammonia atmosphere. Stanley Miller, then Urey's graduate student, did just that in a classic experiment, but Urey was working before the era of planetary exploration. Much has since been learned, both about planets in general and Earth in particular, and some of this knowledge makes geochemists skeptical.

Karen Watson

The Primordial Soup

Little evidence has emerged to support the notion of a hydrogen-rich, highly reducing atmosphere, but some evidence speaks against it. The Isua rocks in Greenland — the oldest known on Earth — have carbonate minerals that James Walker of the University of Michigan says had to form in an atmosphere with carbon largely in the form of carbon dioxide. Because the rocks are some 3.8 billion years old, this reinforces Walker's judgment that the early atmosphere was essentially a carbon-dioxide and nitrogen mix. It might have been mildly reducing, but nothing like the hellish mess that has yielded so many visions of "primordial soup."

Chemists liked that old reducing atmosphere, for it was conducive to evolutionary experiments. Asked what he expected to come out of Miller's flask, Urey once responded "Beilstein," referring to the massive reference tome that lists all known organic chemicals. It's considerably harder to get prebiotic molecules — let alone Beilstein — with the kind of atmosphere geochemists envision, but not impossible. At the University of Houston, John Oro has produced amino acids with an electric discharge in a carbon-dioxide, nitrogen, and water mixture.

Randall Gladstone and Yuk Yung of the California Institute of Technology and Joseph Pinto of the Goddard Institute for Space Studies have run a computer simulation with an atmosphere like our own without the oxygen and several times as much CO_2, plus 0.08 percent hydrogen. Energized by sunlight, a reaction between hydrogen and CO_2 yielded enough formaldehyde for 3 million tons of it to rain into the ocean annually. According to a report in *Science,* scientists think that 10 million years of this would produce enough of a concentration of formaldehyde for more complex molecules to form in reactions driven by sunlight. Such

computerized fantasizing does show that the difficulty of producing higher organic molecules in such an atmosphere is no theoretical barrier to believing it could have happened.

For this and other plausible scenarios, time is of the essence; the gap between the first signs of life and the birth of the planet seems to be narrowing. That Greenland formation, which is always a key exhibit in such discussions, may hold evidence of life, including microfossils.

Manfred Schidlowski and his colleagues at the Max Planck Institute at Mainz have found an indication of photosynthesis in the ratio of carbon isotopes — the relative abundances of C-12 and C-13 — in the Isua rock. Also, Jürgen Hahn at the institute has discovered what he takes to be decomposition products of chlorophyl. However, sulfur, which is also present, does not seem to have a biological origin. Dr. Hahn thinks that the stage in biological evolution where bacterial sulphate reduction began had not yet been reached. Finally, Hans Dieter Pflug of the University of Giessen has reported finding single-cell fossils.

This all points strongly to the presence of life when the Isua rocks were laid down. Unfortunately, in paleobiology, things are often not what they seem to be, and at least some of the evidence has come under strong criticism. An international team of scientists, including Elso S. Barghoorn of Harvard University who pioneered microfossil research, claim that the objects found in the Isua rocks "should not be regarded as evidence of early . . . life forms." The scientists explain in *Nature* that the objects seem to be microstructures of inorganic origin deposited after the rocks had already formed. Indeed, they believe that the geologic changes the rocks have undergone preclude finding credible signs of life.

This is supported by Bartholomew Nagy and a research team at the University of Arizona. After performing thermodynamic calculations and experiments, they doubt that amino acids and other biologically interesting organics would survive the known metamorphic history of the Isua rocks. They say the hydrocarbons recently detected in those rocks are unlikely to be the remnants of organisms that lived 3.6 billion years ago.

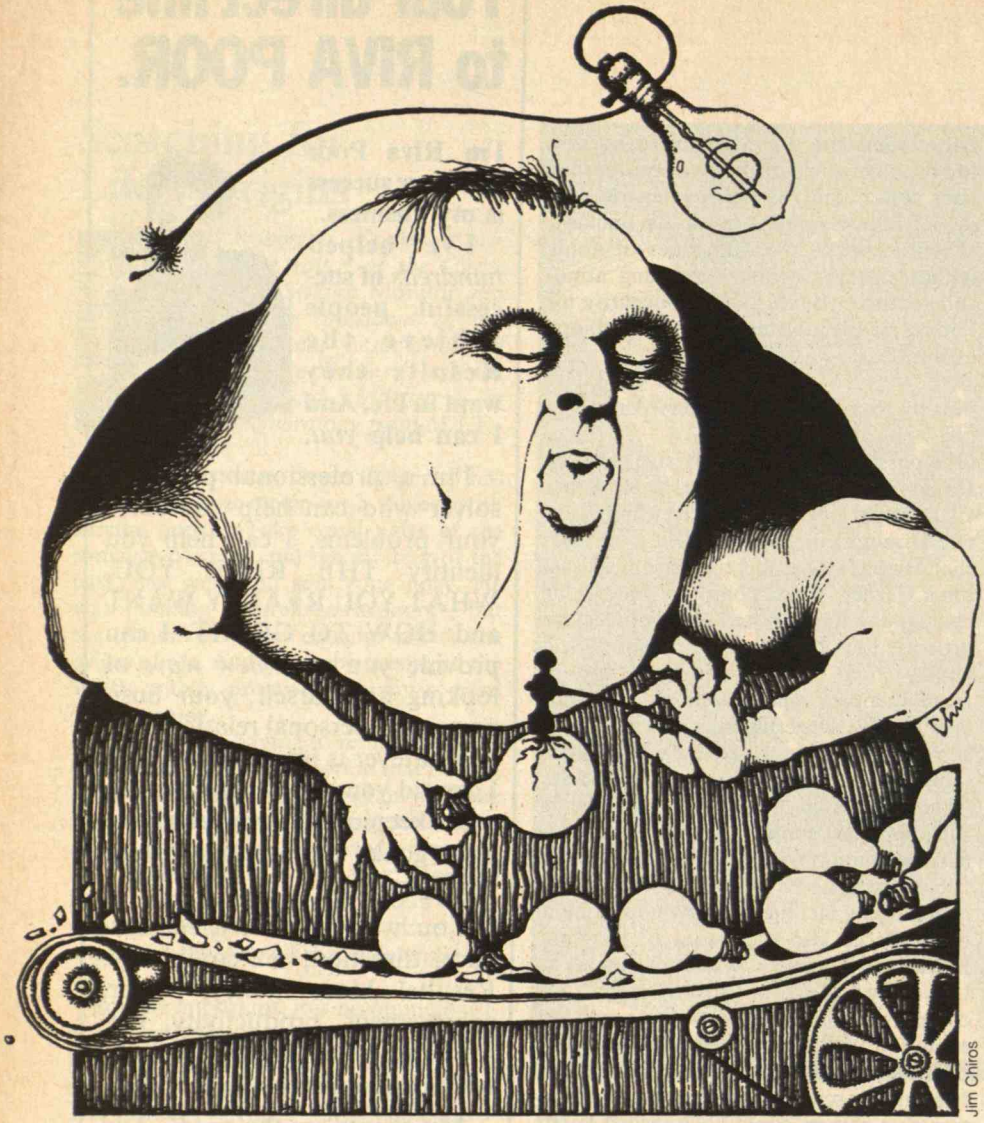
Thus, prebiotic chemists are not compelled by the evidence to squeeze their formation-of-life scenarios into less than a billion years. However, the controversy does underscore the fact that the horizon for the emergence of life has been pushed back considerably in the past few decades — 3.5 billion years is not at all unlikely. When added to the difficulties of doing without Urey's strongly reducing atmosphere, this evidence gives an incentive for finding simpler, faster modes of prebiotic evolution.

Not by Romance and Mystery Alone

One possibility was recently suggested by David White of the University of Santa Clara and the NASA-Ames Research Center. Through computer modeling, he finds that simple self-replicating chemical systems rather than complex molecular chains may have started the evolutionary process. For example, short amino-acid chains could catalyze the formation of more complex nucleic-acid and amino-acid species. Experiments show that such a short amino acid can indeed produce longer chain acids in a simple system. "The success of these first experiments suggests that simple catalytic processes may be common," Dr. White says.

However, some scientists dodge the issue of how fast life arose by importing it from space. The suggestion of Sir Fred Hoyle and Chandra Wickramasinghe at University College in Cardiff, Wales that comets provide an environment for the evolution of life's precursors — or living cells themselves — has met with derision from many scientists, as has the implication that comets could have seeded Earth with life. But there is enough interest for a conference on the subject to have been held last fall at the University of Maryland. As could be expected, nothing definitive emerged; skeptics remained skeptical. Yet, as Armand Delsemme of the University of Toledo in Ohio pointed out, "We need people like Hoyle and Wickramasinghe to shape up all our preconceived ideas."

It would be misleading to say that the line of thinking Urey started is now obsolete; it is still strong in the thinking of prebiotic chemists. But now is a time of ferment and new discovery in this fascinating field. As Owen Gingerich went on to say in giving his recipe, romance and mystery alone won't guarantee appeal. "Interdisciplinary professional competence and imaginative insights combined with a well-grounded skepticism" are also needed. The search for life's orgins offers that in abundance. □



Jim Chiros

A Labor View of Technological Innovation

by William W. Winpisinger

TECHNOLOGICAL preeminence, like so many other traditional American attributes, can no longer be taken for granted. The world's most advanced helicopters malfunction at a critical juncture in Iran, our steel industry is a shambles, our automobiles, trucks, and buses are barely able to hold their own against foreign competition, and U.S. supremacy is seriously challenged even in aerospace, computers, and advanced machine tools.

Declining support for research and development is often cited as a major source of these lags in technological innovation and international competitiveness. Industry blames diminished R&D on the inhibiting effect of business taxes and the diversion of investment from productivity-enhancing technologies to the control of environmental and workplace health hazards.

This is much too simplistic a view of how our economy works. The kind of economic growth that would be produced by "unleashing market forces" would not necessarily improve the general level of well-being. And "quick-fix" solutions such as corporate tax breaks, relaxation of regulations, or simply the pumping of more federal funds into R&D will not necessarily assure economic revival.

After all, while the share of the U.S. gross national product devoted to research and development has fallen steadily since the late 1960s, it remains higher (2.3 percent) than that of our major commercial competitors, West Germany (2.2 percent) and Japan (1.9 percent). Moreover, in the United States R&D scientists and engineers account for a larger share of the work force than in those countries, and civilian R&D expenditures have been growing at a fairly steady rate in real terms. Thus, dwindling financial support for R&D cannot be a primary cause of declining economic strength.

Declining Tax Burdens

The same can be said of the federal corporate tax burden. The standard business litany alleges that taxes have not only drained away private resources that might otherwise have been devoted to R&D, but that they have also reduced the incentive to take risks by reducing the rewards. However, since the end of World War II, there has been a steady *decline* in the federal tax burden on corporations. Accelerated depreciation allowances combined with favorable Internal Revenue Service rulings permitting new accounting devices, investment tax credits, and shelters for overseas earnings have lowered the effective corporate tax rate from 30 to 35 percent in the 1960s to 20 to 25 percent in the 1970s. For our largest corporations, the effective tax rate is currently around 18 percent and projected to fall substantially.

Finally, even if one were to overlook the new "goods" created by environmental and safety regulations in the workplace — cleaner air and water, fewer deaths and injuries — there are serious problems in determining the precise costs of such regulations. Many expenditures that the private sector attributes to compliance in fact represent investments in new and improved production technologies. These investments often result in unforeseen cost savings in other areas. Examples of such accelerated technical progress include new aluminum smelting processes and increased use of scrap in glass manufacture.

Moreover, environmental and workplace regulations have stimulated innovation in pollution-control equipment, measuring devices, and resource-recovery systems. Indeed, without the prodding and guidelines that accompany the government's administration of the public interest, American industrial performance would be even worse. We will restore vigor to our civilian economy only when we confront the fact that technological in-

novation is not isolated from the basic motivating forces of our economy.

An Innovation Monopoly

Traditionally, market competition was supposed to be the major force for technological change. Indeed, many foreign firms that are our major competitors have been disciplined by fiercely competitive conditions in both domestic and export markets. However, for better or worse, competitive markets in the United States seem to be going the way of the dinosaurs. Moreover, the deteriorating trade balance is beginning to exert significant pressure on American business to export goods, but our corporate and industrial establishment is ill-prepared to deal with that challenge.

As recently as 1960, small and medium-sized businesses controlled 50 percent of the nation's corporate assets. Today less than 1 percent of American manufacturers control 88 percent of the industrial assets and receive over 90 percent of the net profits. And this concentration of productive power has been transferred into control over research and development, which is dominated by a small number of very large corporations. The top 10 percent of those firms in 1976 performed almost 70 percent of the total U.S. research-and-development effort. Small firms received less than 4 percent of government outlays for R&D.

We could expect to see a true flowering of innovation from these corporate giants with this level of resources at their disposal. Yet a recent unpublished study by the Office of Management and Budget credited firms having fewer than 1,000 employees with almost half of the industrial innovations between 1953 and 1973. These are the firms the conglomerates are gobbling up in the current wave of takeover activity. This process of economic concentration influences industrial innovation. Conglomerate firms, insulated from market forces, and oligopolistic firms that essentially call the shots in the markets they dominate have much greater control over their rate of innovation than small firms that function in more competitive conditions.

The business community itself is groping for reasons for the attenuation of the great American spirit of entrepreneurship among its ranks. Some suggest that the problem lies with executives with backgrounds in finance and legal matters. These people tend to have little knowledge of long-term product development and markets and instead focus on short-term profitability and minimization of risk.

It is not surprising to find large firms buying up innovative companies, not necessarily to exploit new technology but often to suppress it or to control its progress to market. Recently a high Commerce Department official was asked if the government intended to continue to reserve a portion of its R&D dollars for small business. He replied affirmatively, stating that acquisition of these firms seemed to be the *only* way of getting new technology into the larger firms.

Our recent history is filled with examples of new products and techniques — stainless-steel razor blades, radial tires, front-wheel-drive automobiles, sophisticated and reliable machine tools — introduced from abroad and adopted by American firms only when foreign competition began to threaten. Moreover, a number of key technologies developed in the United States — improved steel making, for example — have helped our competitors race ahead while U.S. companies cling to older, less productive methods.

Mired in the Corporate State

The inhibition of technological innovation is nowhere more apparent than in our domestic automobile industry. General Motors has made and sold small diesel-powered automobiles (the Opel) in West Germany since the 1930s, but failed to produce them here until forced to by intense pressure from foreign manufactur-

Continued on page 24

William W. Winpisinger is president of the International Association of Machinists and Aerospace Workers.

THE LEADING EDGE

#1 in a series of reports on new technology from Xerox

About a year ago, Xerox introduced the Ethernet network—a pioneering new development that makes it possible to link different office machines into a single network that's reliable, flexible and easily expandable.

The following are some notes explaining the technological underpinnings of this development. They are contributed by Xerox research scientist David Boggs.

The Ethernet system was designed to meet several rather ambitious objectives.

First, it had to allow many users within a given organization to access the same data. Next, it had to allow the organization the economies that come from resource sharing; that is, if several people could share the same information processing equipment, it would cut down on the amount and expense of hardware needed. In addition, the resulting network had to be flexible; users had to be able to change components easily so the network could grow smoothly as new capability was needed. Finally, it had to have maximum reliability—a system based on the notion of shared information would look pretty silly if users couldn't get at the information because the network was broken.

Collision Detection

The Ethernet network uses a coaxial cable to connect various pieces of information equipment. Information travels over the cable in packets which are sent from one machine to another.

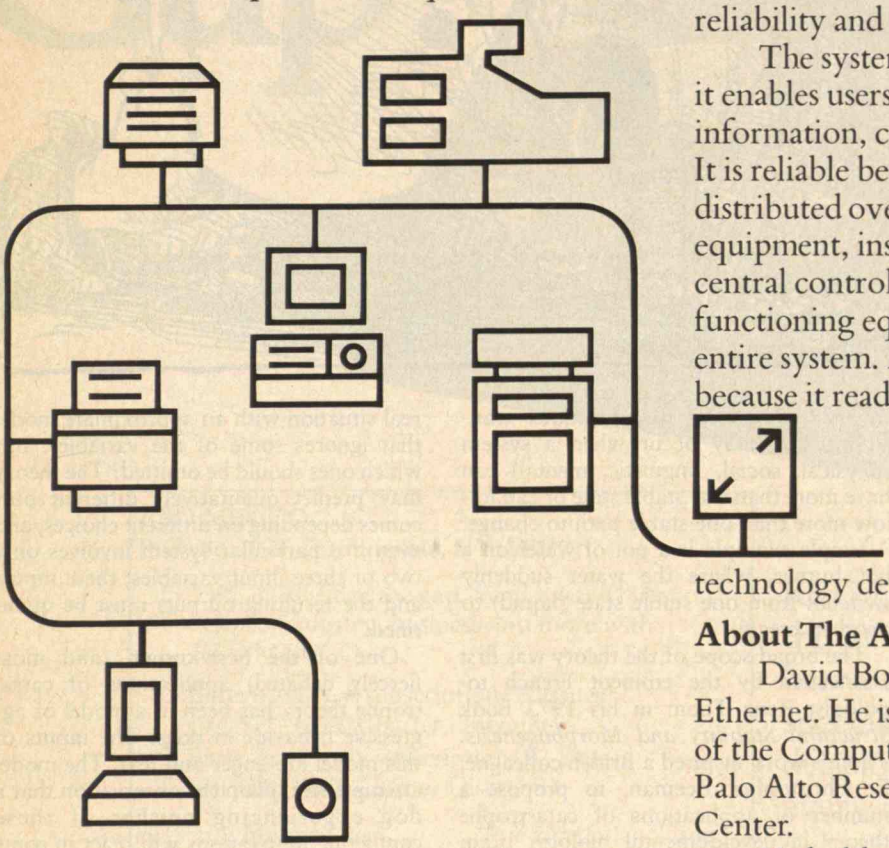
A key problem in any system of this type is how to control access to the cable: what are the rules determining when a piece of equipment can talk? Ethernet's method resembles the unwritten rules used by people at a party to decide who gets to tell the next story.

While someone is speaking, everyone else waits. When the current speaker stops, those who want to say something pause, and then launch into their speeches. If they *collide* with each other (hear someone else talking, too), they all stop and wait to start up again. Eventually one pauses the shortest time and starts talking so soon that everyone else hears him and waits.

When a piece of equipment wants to use the Ethernet cable, it listens first to hear if any other station is talking. When it hears silence on the cable, the station starts talking, but it also listens. If it hears other stations sending too, it stops, as do the other stations. Then it waits a

random amount of time, on the order of microseconds, and tries again. The more times a station collides, the longer, on the average, it waits before trying again.

In the technical literature, this technique is called carrier-sense multiple-access with collision detection. It is a modification of a method developed by researchers at the University of Hawaii and further refined by my colleague Dr. Robert Metcalfe. As long as the interval during which stations elbow each other for control of the cable is short relative to the interval during which the winner uses the cable, it is very efficient. Just as important, it requires no central



control—there is no distinguished station to break or become overloaded.

The System

With the foregoing problems solved, Ethernet was ready for introduction. It consists of a few relatively simple components:

Ether. This is the cable referred to earlier. Since it consists of just copper and plastic, its reliability is high and its cost is low.

Transceivers. These are small boxes that insert and extract bits of information as they pass by on the cable.

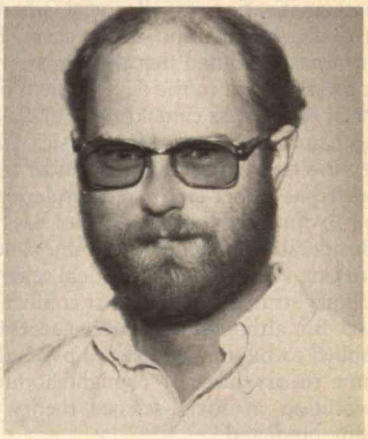
Controllers. These are large scale integrated circuit chips which enable all sorts of equipment, from communicating typewriters to mainframe computers, regardless of the manufacturer, to connect to the Ethernet.

The resulting system is not only fast (transmitting millions of bits of information per second), it's essentially modular in design. It's largely because of this modularity that Ethernet succeeds in meeting its objectives of economy, reliability and expandability.

The system is economical simply because it enables users to share both equipment and information, cutting down on hardware costs. It is reliable because control of the system is distributed over many pieces of communicating equipment, instead of being vested in a single central controller where a single piece of malfunctioning equipment can immobilize an entire system. And Ethernet is expandable because it readily accepts new pieces of information processing equipment. This enables an organization to plug in new machines gradually, as its needs dictate, or as technology develops new and better ones.

About The Author

David Boggs is one of the inventors of Ethernet. He is a member of the research staff of the Computer Science Laboratory at Xerox's Palo Alto Research Center.



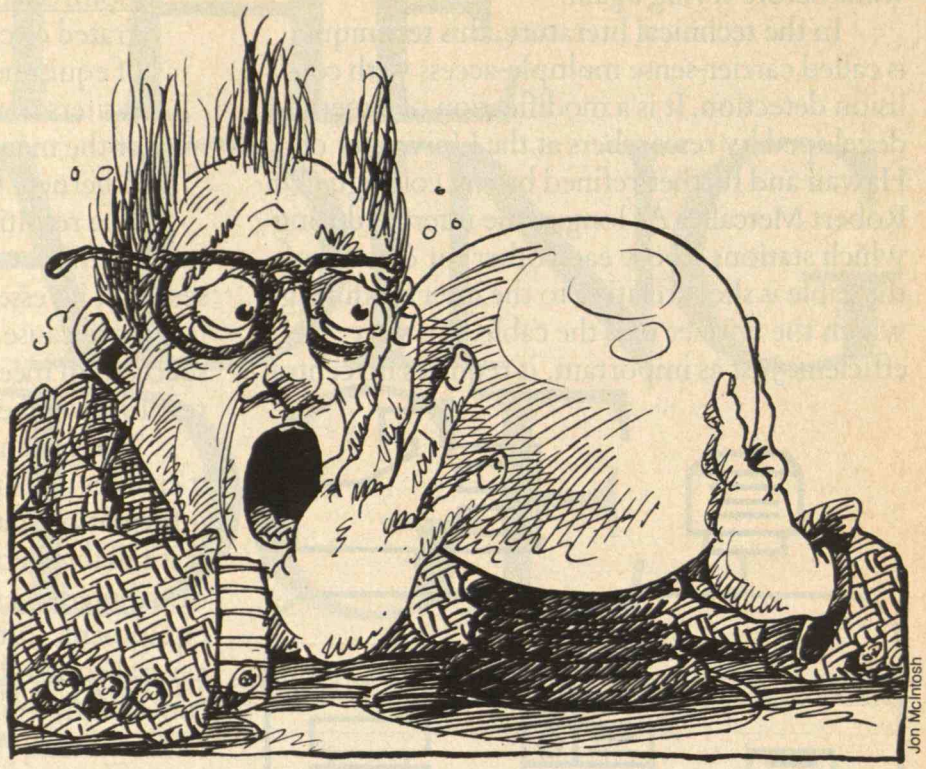
He holds a Bachelor's degree in Electrical Engineering from Princeton University and a Master's degree from Stanford University, where he is currently pursuing a Ph.D.

XEROX

Predicting the Unpredictable

Catastrophe Theory
Alexander Woodcock and Monte Davis
New York: E.P. Dutton, 1978, 152 pp., $9.95

Reviewed by Michael Olinick


Jon McIntosh

Mathematics has been a spectacularly successful tool for describing and analyzing the physical world. It is almost impossible to imagine contemporary physics or chemistry without the mathematics routinely studied by today's college freshmen, not to mention its more abstract applications.

No wonder, then, that the twentieth century has witnessed repeated attempts to discover mathematical tools that would achieve similar success for the biological and social sciences. In the 1930s, for example, the "topological field theory" of Gestalt psychologist Kurt Lewin was touted as the tool that might revolutionize sociology and psychology. Although Lewin's work inspired a number of optimistic attempts to remodel the so-called "soft" or "inexact" sciences, no lasting contributions were ever made. The books and papers generated by this movement now gather dust on library shelves.

The Ultimate Mathematical Tool

In the 1950s, von Neumann and Morgenstern's theory of games was proposed as the breakthrough that would create a mathematization of all social situations involving conflict and cooperation. Early enthusiasts claimed that the theory would be as important to the development of the social sciences as calculus was to classical mechanics and Newtonian physics. Unlike Lewin's topological diagrams, now rightly viewed as rather sterile recapitulations of the obvious, the theory of games has had a considerable impact on economics and the working vocabulary of political scientists, military strategists, and other conflict analysts. But although it has been successfully applied to biology and social psychology, game theory has not brought about the revolution in social-science theory that many predicted.

In the past decade, a new candidate for the ultimate mathematical tool emerged: applied catastrophe theory. Catastrophe theory focuses on discontinuous transitions that may occur when a system (physical, social, linguistic, mental) can have more than one stable state or can follow more than one stable path to change. A simple example is a pot of water on a hot burner, where the water suddenly switches from one stable state (liquid) to another (steam).

The broad scope of the theory was first enunciated by the eminent French topologist Rene Thom in his 1972 book *Structural Stability and Morphogenesis*. Thom's work inspired a British colleague, E. Christopher Zeeman, to propose a number of applications of catastrophe theory in developmental biology, brain modeling, stock exchanges, threatened dogs, prison disturbances, and the stability of ships. Nearly all of these possible applications are related to an elegant classification theorem formulated by Thom, which asserts that if a system is governed by a potential and its behavior is determined by at most four control factors, then only seven qualitatively different types of discontinuity are possible.

In attempting to apply Thom's theorem to complex biological or social phenomena, one encounters two major problems. If the real-world situation is governed by more than four input variables, then catastrophe theory is not directly applicable. One has to replace the real situation with an approximate model that ignores some of the variables. But which ones should be omitted? The theory may predict qualitatively different outcomes depending on different choices, and even if a particular system involves only two or three input variables, these inputs and the resulting outputs must be quantified.

One of the best-known (and most fiercely debated) applications of catastrophe theory has been in a model of aggressive behavior in dogs. The inputs of this model are anger and fear. The model attempts to explain the observation that a dog experiencing neither of these conflicting motivations will react in some neutral fashion, but an animal subjected to high levels of both drives will either attack or flee. These two extreme modes of response are treated as opposite ends of a spectrum meant to measure "behavior." Critics have been quick to point out that "fear," "anger," and "behavior" are extremely difficult, if not impossible, to quantify in a careful fashion.

Beyond the Brouhaha

Advocates of catastrophe theory as a new way of thinking about change and evolution have been extreme in their praise. They have called it a "revolution" that affords novel insights into the world in

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which we live, and "the most important development since calculus," with a "scope and application that appear to be virtually unlimited." Reviews have not been limited to specialized academic volumes but have spilled over to the more widely read journals and the mass media. Many in the American mathematical community, concerned about withering public support for research, have seized upon catastrophe theory as evidence that abstruse mathematical investigations can quickly lead to important payoffs for the general public.

It is not surprising that such strong views have been met with criticism; what is surprising is the ferocity of some of these reactions. Debates about the value of catastrophe theory and its potential applications have given rise to an intense controversy rare in mathematics. One widely respected mathematician labeled the claims of proponents of catastrophe theory "exaggerated, not wholly honest . . . the height of scientific irresponsibility." Another warned that catastrophe theory "can lead to dangerously wrong conclusions."

The most extended critique of the applications of catastrophe theory to the social and biological sciences comes from two Rutgers mathematicians, Hector J. Sussman and Raphael S. Zahler. They charge that "catastrophe theorists have misused the basic mathematics in ways that lead to indefensible arguments; offered models based on unreasonable assumptions [that are] frequently vacuous, tautologous, vague, or impossible to test experimentally."

Difficulties face lay readers who seek an objective, comprehensible account of catastrophe theory or social and life scientists who wonder whether their understanding of various problems can be enhanced by the Thom-Zeeman approach. A balanced treatment of the subject by a dispassionate observer is not yet available, but the short book by Woodcock and Davis is a good introduction. Woodcock, a biologist at Williams College, and Davis, a science writer, provide a nontechnical, well-illustrated discussion. While clearly advocates of the theory, they nonetheless explore the reasons for the controversy and admit that the fundamentally qualitative nature of Thom's geometric approach has its limitations.

Michael Olinick is professor of mathematics at Middlebury College. □

Witch-Hunting for Risks

Societal Risk Assessment: How Safe Is Safe Enough?
Richard C. Schwing and Walter A. Albers, Jr., eds.
Plenum Press, 1980, 362 pp.

Reviewed by Fred Hapgood

It has been said that it is an infallible sign of poor government when citizens interest themselves in their rights. What then should be said about a society whose members seem preoccupied with the risks of living in it? Especially one in which, within the memory of many still alive, several dread diseases have been routed and the general life expectancy increased substantially? That we are neurotic and self-indulgent and don't know when we are well off? That our concern is rational because public health and medicine have given us more to lose? Or that some other agenda entirely is being pursued, camouflaged in the language of risk?

One might even argue societies have always been fascinated by lowering the threat of things malign, unexpected, and uncontrollable, and that we devote no more conversation or emotional energy to those threats than any other. Perhaps. But there certainly are some differences, among them the extraordinary degree to which we have reified the idea of risk itself.

Personal Chemistry and Scuttlebutt

There was a time in which the word risk was never employed, except in the context of a specific hazard: crossing the street, hitchhiking across Asia, becoming a poet. In the last ten years or so, a whole new profession has appeared whose members hardly ever mention concrete situations. They deal only with risk itself, as though it has some sort of Platonic reality, as homogeneous and primal as Lucretius' atoms, embodied now in one form — saccharin, nitrosamines, dioxin — and now in another — nuclear war, hang gliding, terrorists.

The volume at hand, the proceedings of a symposium at the General Motors Research Laboratory, is an instance. The flavor of the presentations can be suggested by summarizing three. "Risk-Spreading Through Underwriting and the Insurance Institution," by J.D. Hammond of Pennsylvania State University, reviews the behavior of that class of organizations that make a business out of exposing themselves to risk. Hammond is especially interested in the decision to underwrite projects — usually based on new technologies — for which there is not enough experience to construct an actuarial table. His paper is of interest because the issue of dealing with exposure to new, complicated risks is a general one, and because if anyone could be expected to have figured out an intelligent approach, it would be insurance companies. Alas, "The insurance underwriting decision process is often viewed as scientific, precise, and capable of accurate risk assessment," he begins. "In fact . . . the companies rely on what is called 'judgment underwriting' and reinsurance. These decisions are made, as such decisions always are, on personal chemistry and scuttlebutt. As Hammond puts it somewhat more delicately, "Underwriters may meet directly with top management officials in an attempt to assess general attitudes and abilities. . . . The position or quality often sought is a high degree of mutual trust." He also stresses the importance of trust in reinsurance underwriting. In other words, insurance companies do not mind exposing themselves to unknown and uncertain risks, so long as they believe that the people they are dealing with are telling the truth.

"Facts and Fears: Understanding Perceived Risk" by Paul Slovic, et al., of Decision Research will probably attract the lion's share of whatever citations this volume receives. The authors show that many factors determine the scariness of a given risk: its novelty, its personal impact, the inequitability of its risks or benefits — 18 in all. Such a large number of factors would make calculating public reaction to a given situation hard enough, but the authors are also gloomy about the prospects of deriving weighting functions that will allow risk assessors to put all these factors in a single equation.

For example, the most important factor is "catastrophic potential." Quantifying this requires hanging weights on the probability and severity of an accident. Probability assessments, which are actuarial tables, require large amounts of data to be convincing. Severity is even more difficult to quantify, since the authors say they have found three disparate opinions in

their polls as to the proper relationship between "social cost" and number of lives lost: that large losses of life are more important (perhaps because they threaten the resilience of a community), that all lives are of equal value, and that greater efforts are called for when *small* numbers are involved. "Clearly, any attempt to model the impact of a multiple-fatality event will need to consider how situational factors will interact with these multiple values," they conclude, which sounds to me like so much whistling in the dark. Do they really believe that those "situational factor interactions" are ever going to be quantifiable? And even if they are, how about the other 17 factors? What sort of weighting scheme do they propose for the social equitability of risks, costs, and benefits?

The Zeal of the Search

In "Witches, Floods, and Wonder Drugs: Historical Perspectives on Risk Management," William Clark of the International Institute for Applied Systems Analysis suggests that risk management creates risk as well as controls it. He introduces this idea with a provocative, even brazen, parallel between his colleagues and the witch-hunters of the Inquisition. The belief in witchcraft as a source of misfortune is probably as old as the species. Historically, however, remedy was left to local communities, who tended to see the problem less as one of witches in any abstract sense than as specific deviants known to the parish. From a national level, however, the problem of witches was not one of that evil Dame Johnson up the road, but witches pure and abstract, and from that perspective, the problem was pervasive. Every community reported some problem with them, and the need for a systematic, national solution was clear. The best experts were mobilized, the power of the state was placed in their hands, and the Inquisition rolled into action.

Clark points out that while there was a formal definition of guilt — confession — at the time of the Inquisition, there was none for innocence. The prosecutor could torture the accused for as long as he wished. Since torture will drive most humans to confess to anything sooner or later, Clark argues, this made the number of detected witches a direct function of the zeal of the search. That in turn set up a calamitous feedback cycle: the more effort, the more witches; the more witches, the more effort called for. The result was that more than half a million people were burned at the stake, largely "for crimes they committed in someone else's dreams."

Clark's point is that the same lack of "stopping rules" characterizes risk management. "What is not a risk with a parts-per-million test can always be exposed to parts-per-billion examination. If rats cope with the heaviest dose of a chemical that can be soaked into their food or water, you can always try mice or rabbits. Again, the only stopping rule is discovery of the effect." He concludes with a call to localize risk-management decisions, "even down to the level of the individual."

These three papers reflect a perplexing general disparity between the tone and content of the conference. Everyone, speakers and discussants, gave off an air of making serious contributions to an ongoing enterprise of considerable social value. Yet paper after paper raises points that seem absolutely fatal to the proposition that any sort of national risk-management policy is possible. If even insurance companies — no doubt against their natural inclination — are forced to rely on subjective, if educated, intuition; if risks are basically heterogeneous, so that lives lost from different hazards cannot be added or compared; if the important determinants of risk are not quantifiable; if risk management increases the sense of hazard (perhaps by heightening one's awareness of different exposures), what then is left of the field?

"I feel a bit uncomfortable," said the concluding speaker, Howard Raiffa of Harvard, "[over the] paucity of proposals for helpful first steps. . . . We have to be politically relevant and offer concrete, pragmatic suggestions. I missed hearing such proposals."

Such proposals were not made because most speakers were expounding upon reasons why they were logically and politically impossible. Yet the tone of the affair embodied a perplexing confidence that such proposals could be found. It is the fable of the emperor's clothes, but with this twist: the emperor himself is pointing out that his new suit is invisible, and nobody, not him, not the little boy, not anyone else, believes him.

Science writer Fred Hapgood's latest book is Why Males Exist, *a study of the evolution of gender systems.* □

Physics Made Easy

From Atoms to Quarks
James S. Trefil
New York: Charles Scribners and Sons, 1980, 288 pp., $12.95

Reviewed by David Root

James S. Trefil presents the extraordinary story of how modern physics has come to recognize, and largely explain, the strange world of elementary particles. All this is done for the "intelligent general reader" using mathematics no more sophisticated than simple arithmetic. That so much can be accomplished with so little formalism may raise a few eyebrows among those who would claim that a paucity of mathematics reflects a lack of clarity of thought. But simple mathematics can be a powerful tool for both quantitive predictions and increased understanding.

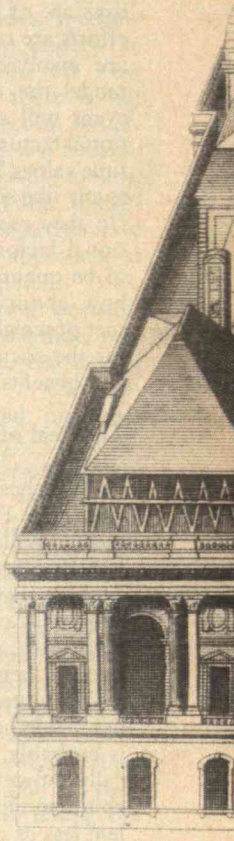
Much of the book illustrates how schemes were developed to classify data in the seemingly chaotic world of natural phenomena. Trefil begins his story with the atomic theory of Dalton at the beginning of the nineteenth century, when the known chemical elements were thought to contain a few diverse, featureless spheres (atoms) arranged in different ways. The world looked very simple, but the discovery of more elements sent these perceptions into confusion. Order was later established by Mendeleev and his periodic table, whereby available data were conveniently grouped. Although an explanation for the observed regularities of chemical properties did not result from the periodic table, it called attention to obvious gaps in data. This, in turn, hastened the discovery of new elements expected to complete the puzzle.

The discovery that the atom is composed of constituent particles, the number and arrangement of which determine its atomic properties, shed new light on the problem. But just as physicists' understanding solidified, more subatomic particles were discovered in cosmic rays and through the use of the new accelerators. The once-simple picture of an atom and its protons, neutrons, and electrons was clouded by these newcomers with their strange properties. The neutrino, for instance, is so slightly affected by matter that it could conceivably travel several light years through lead without a single

Continued on page 24

Reflections on the Resurrection of Urban Design

by I.M. Pei



THESE are exciting times for architects. Even as we design many novel and interesting structures, there is vigorous discussion of future directions. Some say we need to reinterpret the great schools of thought from the past, while others believe it is time to strike out in altogether new directions. All this ferment has injected a tremendous liveliness into our profession, but it hardly reflects the truth of our situation. Despite the many new and exciting buildings, our cities, as objects of design, are in a terrible state. They are becoming uglier by the day. Everywhere we look — New York, Boston, Chicago, Los Angeles — there is a complete absence of attractive and purposeful city design. The urban environment, beset by architectural confusion, has become a visual disaster.

Surely the time has come to reflect on what is happening and on what history can tell us about the planning and design of great cities in the past.

City Planning Through the Ages

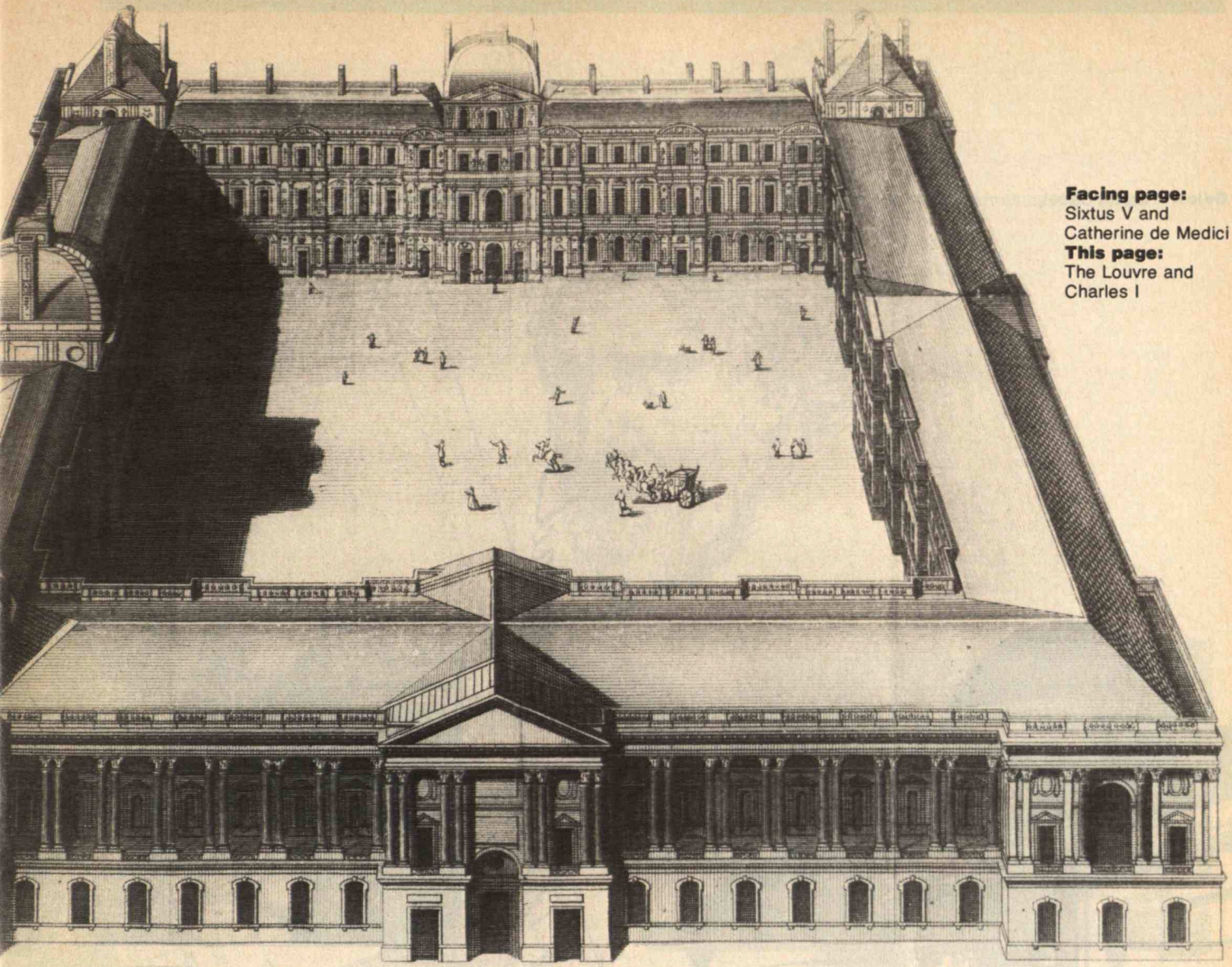
Western civilization did not achieve truly effective city design until the sixteenth century. It was only then that what can fairly be called an urban culture was achieved in Rome and later in Paris. What made Rome and Paris successful examples of urban design? These great cities were both under the absolute control of church or state, and both were shaped by a few dominant individuals.

Sixtus V, pope at the end of the sixteenth century, single-handedly gave form to Rome. His imprint is visible in every direction from the top of the Santa Maria Maggiore — the church itself is familiar to many, the panoramic view much less so. From this vantage point, one can see the major Roman avenues running for miles. Unlike our modern avenues, the intersections of these streets were always punctuated by a piazza with an obelisk and a church.

Sixtus created this framework — the backbone of Rome — in just five years, and it was so right and so strong that it remained the master plan for the entire 300 years required to finish the city around it. What we see today in Rome is a result of that work. This was perhaps the most grandiose piece of city planning ever attempted, and it occurred within the lifetime of a single man.

Toward the end of the sixteenth century, Catherine de Medici, who was married to King Henry II of France, introduced the concept of urban planning to France. She had traveled throughout Europe, especially to Rome and Florence, and she began the construction of what culminated in the Louvre as we know it today. She initiated the building of Paris as Pope Sixtus had done in Rome. Later generations completed the form of Paris and its surrounding countryside. Le Notre, the greatest landscape architect of the early eighteenth century, advised

Facing page:
Sixtus V and
Catherine de Medici
This page:
The Louvre and
Charles I



Louis XV. But even more important was the work of Baron Hausmann and Napoleon III, who had absolute power and took over from the church the function of city planning. The Paris we see today is largely the result of one century of enlightened, if autocratic, building.

Consider, for instance, the democratic tradition of English town planning. By what means did England create its great cities of London, Bath, and Edinburgh? Planning was introduced on a large scale by King Charles I. Though the country

Charles R

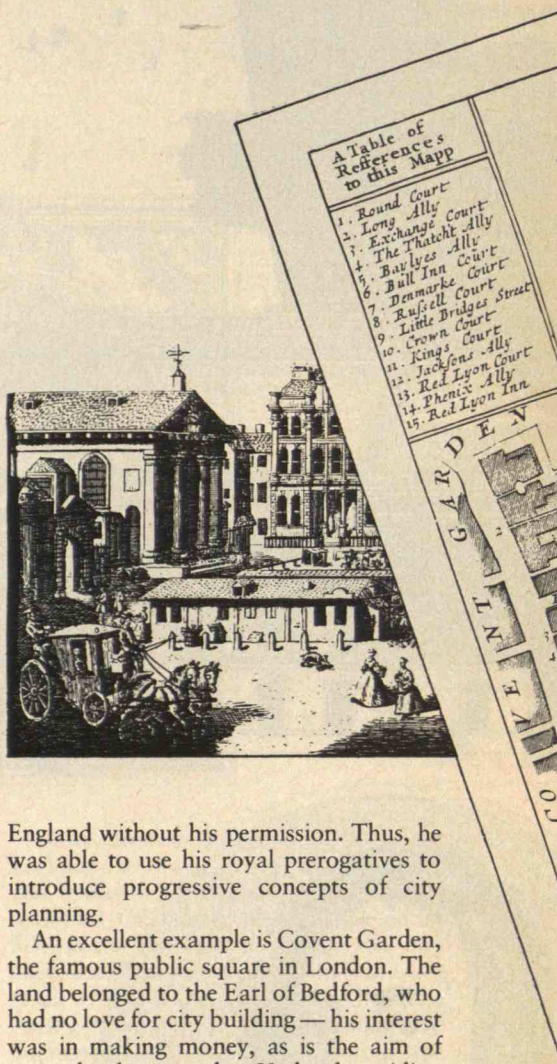
England: The Enlightened Speculators

No individual today could dominate, as Napoleon and Catherine de Medici did, the development of something as complex as a modern city; great cities can no longer be built in a single generation. But there are other lessons to be learned.

was a monarchy, Charles I did not have the power of Sixtus, Catherine de Medici, or Napoleon. Most properties in England in the seventeenth century were owned privately rather than by the crown. But Charles I had one particularly important power: no one could develop properties in

Below: Regent Street.

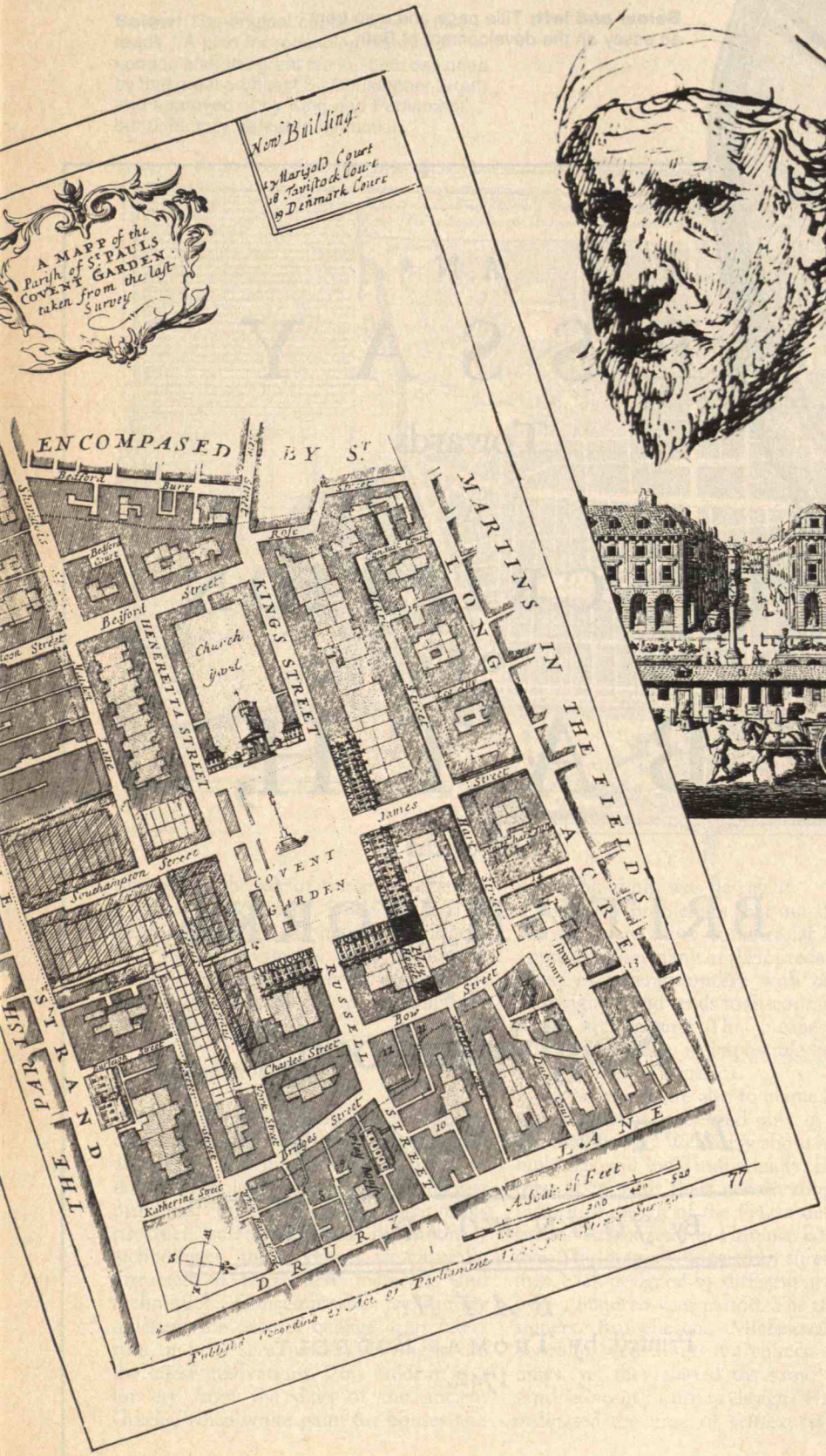
Below: Covent Garden in the mid-eighteenth century.



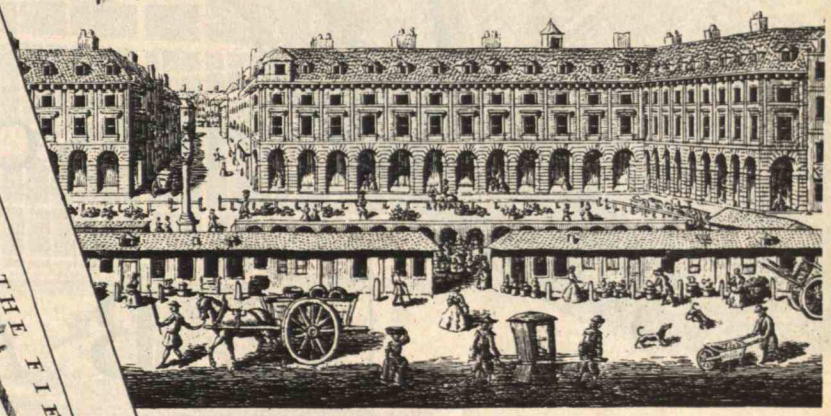
England without his permission. Thus, he was able to use his royal prerogatives to introduce progressive concepts of city planning.

An excellent example is Covent Garden, the famous public square in London. The land belonged to the Earl of Bedford, who had no love for city building — his interest was in making money, as is the aim of many developers today. Under the guiding hand of Charles I, however, the earl's land was transformed into a paragon of civic design.

Of course, there must have been an architect, too. England in the early seventeenth century was blessed by the presence of Inigo Jones, the designer of Covent Garden. Jones was what we would call an amateur — a cultivated amateur — of architecture. He traveled extensively in Italy, where he fell in love with Andrea Palladio's work. Upon his return to London, he persuaded his royal connections that he should serve under the king.



Left: A self-portrait by Inigo Jones.



John Nash, another important figure who gave shape to London, was a speculator wise enough to use his royal connections and to hire good architects. With their help, he built Regent Street, which connects the great parks of St. James and Regents Park, and many of the important parts of London. What Sixtus was to Rome, John Nash was to London.

A third name must also be included: Christopher Wren. Wren was important because, in addition to having the prerequisite royal connections and a good education in architecture and the arts, he was born at a most fortunate time — the Great Fire of London. While I do not recommend that we burn our cities, the Great Fire of 1666 gave Wren the chance to rebuild London. The city needed a lot of new buildings in a short time, and builders opted for no-nonsense structures limited to very few designs. The builders adopted vernacular architecture — vernacular meaning that every carpenter and brick-

Below and left: Title page and map from an essay on the development of Bath.

AN

ESSAY

Towards

A

DESCRIPTION

OF

BATH,

And of the

BRITISH WORKS

IN ITS

Neighbourhood.

In TWO PARTS.

By *JOHN WOOD*, Architect.

BATH:
Printed by THOMAS BODDELY.
1742.

layer knew how to do it. All one had to do was tell the builder, "I want house type A-4 or A-5," and it would be done. This vernacular architecture was subsequently developed into a highly adaptable yet refined style known as Georgian.

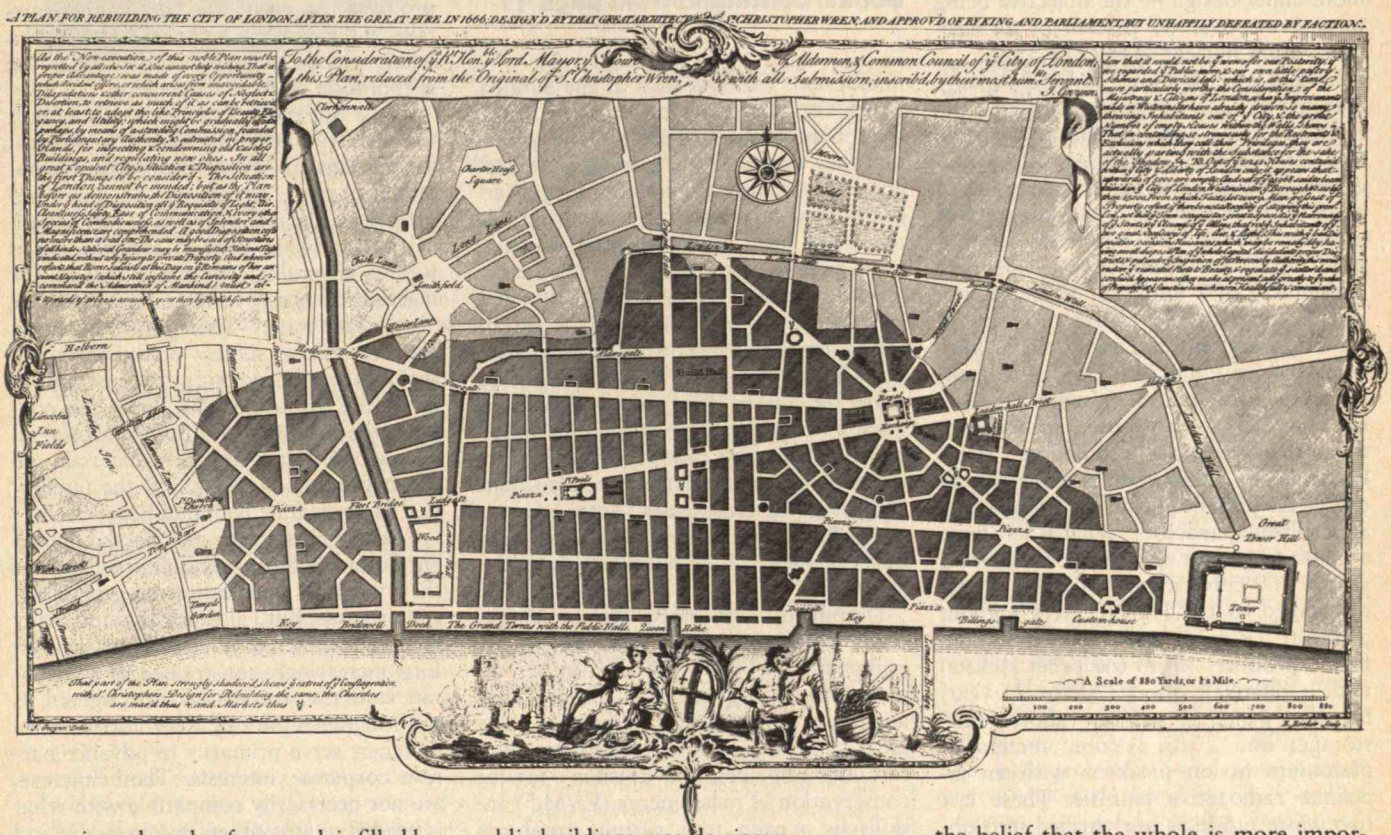
Great works were also created in Bath, where the significant developer was Sir John Wood. Like our builders today, Sir John was an avowed speculator, but he had the good taste and sense to hire good architects. So today we have the beautiful city of Bath — English Baroque at its best.

The England of the late seventeenth and eighteenth centuries had the fortunate mixture of power, wealth, and ideas. Great cities are built this way — very simply, with control, luck, and the proper proportions of patience and balance. Even today, some 200 years later, the same tradition is being followed. The London we see is the work of a few individuals.

I would like to think that America today possesses that same combination. In

Below: The original caption for this map reads, "A plan for rebuilding the city of London after the great fire in 1666; designed by that great architect Sir Christopher Wren; and approved of by King and Parliament, but unhappily defeated by faction."

I. M. Pei is a leading figure in contemporary architecture. This report is based on his remarks at an M.I.T. Corporation meeting last year.



our society, the role of monarch is filled by a governor or mayor, while the Earl of Bedford would be our myriad developers. The English examples offer encouragement: if we emulate them, perhaps the modern-day system can make something of our chaotic cities.

Plastics and Profits

We must not forget that today's problems are much more complicated than those of eighteenth and nineteenth century London. Technology is one of our biggest problems. Our educational institutions produce scientists who invent new technologies, and architects are naturally attracted to these new materials and techniques. Consequently, technology quickens the pace of change in architecture, and one sees builders striving to use the latest innovations. This faddism is a far cry from the days of the ancient Greeks, when white paint for houses and public buildings was de rigeur.

A further problem is that our developers today are more commercial in their approach than many of their predecessors. Their overriding concern with profits is shortsighted and tends to discourage good urban architecture. This business mentality may make it impossible to build greater cities in America.

We architects are also to blame because we seem to be interested only in "doing our own thing." We worry about how our buildings will look individually, not how they fit in with their surroundings. The history of design of the Piazza della Santissima Annunziata in Florence is instructive. This piazza is formed by three buildings, each designed by different architects over a hundred-year period. The three designers, Brunelleschi, Michelozzo, and Sangallo, were all great architects of their times, yet they shared the same Renaissance concept of urban design. They subordinated the urge of self-expression to the belief that the whole is more important than the parts. Boston's Beacon Hill is another excellent example of how harmonious building designs can create an attractive urban environment.

Our egotism and shortsightedness in terms of profits are our curse: they prevent us from reaching for order and harmony in our designs. In addition, we are hampered by the lack of power — the kind of power to set guidelines that helped make Paris what it is today.

This is a time of freedom and excitement for individual architects, but we are not thinking the way a civilized society should about building a civilized community for people. The three elements needed to build great cities — wealth, ideas, and power — must be brought together once again. We will need leadership to combine our strength in science and engineering with the vision of architecture and the arts if we are to build beautiful cities for our future. □

Letters/Continued from page 4

Phénix and Super-Phénix sites. But France lists over 50 units at 20 different locations of pressurized-water, gas-graphite, heavy-water, and breeder reactors, each installation generally in the 925-megawatt category. France generates about 12.8 percent of its electrical needs from uranium — about in line with the United States, but a sharp increase from the 8 percent generated in 1973. Compared with 26.5 gigawatts today, France has 47.9 gigawatts under construction with more under design — the objective being to generate over 60 percent of all electricity from nuclear sources by 1985.

Instead of continuing to hold "spent" uranium at each nuclear reactor site, the French send the spent pellets to Marcoule to be reprocessed. Out of each 100 kilograms, what is recovered includes 95 kilograms of uranium-238 and 1 kilogram of uranium-235 (or 96 kilograms of uranium-238, enriched with 1 percent uranium-235); 1 kilogram of plutonium; and 3 kilograms of fission products to condition and store. The 95 to 96 kilograms of uranium-238-235 is then enriched to uranium-238-235 with 3 percent uranium-235 content, used to recharge the nuclear electricity installations. The 1 kilogram of plutonium is collected to charge the present Phénix (or forthcoming Super-Phénix) reactors. What is left from a 1,000-megawatt reactor operating for a year is 100 cubic meters of waste water, discharged to the French rivers without incident; 15 cubic meters of zirconium fission products (from the pellet jackets) with a relatively short (20- to 25-year) half-life, which is sent to "short time" storage; and 2 to 3 cubic meters of plutonium fission products with an indefinite radioactive half-life. These last two waste products are vitrified into obsidianlike glass mixtures and sent to storage in granite caverns in Brittany.

A year's operation of a 1000-megawatt reactor produces only a "chunk" of highly radioactive material about a yard square and two to three yards high, which the French do not believe presents a dangerous threat to the fibre of society. By putting aside the fears typified by Professor Bupp's article and magnified by a small minority of scientists and media, the French (and British) are forging ahead to a solution to their energy problem, instead of dithering about as the United States is today.

Henry F. Lippitt II
Los Angeles, Calif.

Mr. Lippitt is an attorney in the energy field and a former staff member of the New York office of the U.S. Atomic Energy Commission. – Ed.

Moder's Law

"The two social catastrophes now threatening us are nuclear war and resource exhaustion," says Kenneth E. Boulding in "Is Blood Thicker Than Water?" (*October, p. 6*). But that statement violates Moder's Universal Law of Ignorance: that our greatest social risk lies in those things that we do *not* perceive rather than those we do.

Thomas D. Moder
Oakland, N.J.

Books/Continued from page 17

interaction. Particles such as the lambda, which decay at rates much more slowly than hypothesized, were so unexpected that they were dubbed "strange particles" and there are even whole families of entities called resonances so short-lived that physicists have been reluctant to label them as particles.

Most of these seemingly bizarre particles of matter are composed of certain simple combinations of fundamental particles, called "quarks." Quarks were originally thought to come in only three varieties, an enormous reduction of complexity. However, the rules by which quarks combine to form particles are also quite simple. Using these rules, Trefil writes a compelling construction manual for various particles, all without elaborate formalism.

Despite its vast scope, the book succeeds because Trefil is able to explain coherently a prodigious number of phenomena using only basic physical laws and their elementary consequences. The great conservation laws, Heisenberg's uncertainty principle, and Einstein's law of conservation of mass-energy ($E=Mc^2$) are skillfully woven into various combinations throughout the book. Another noteworthy aspect is Trefil's description of the specific measurements and detection devices of experimental physics. These define and reinforce the theoretical concepts previously introduced and show how a physical system is altered by the process of measuring it.

Of course, the book does not escape criticism completely. For example, at one point, the photon is assigned both spin zero (incorrect) and spin one (correct). Also, the relative strength of gravity as compared with the other three forces of nature is not mentioned until the end: the naive reader could wrongly assume that gravity can play a role in holding an atom together. Because the planetary analogy for the atom is used extensively, gravity might well have been discussed earlier.

David Root is a graduate student in physics at M.I.T. □

Forum/Continued from page 11

ers. This procrastination led to catastrophic worker layoffs throughout the industry and its subcontractors.

The Arab oil embargo of 1973 should have warned American auto manufacturers that cheap, reliable oil supplies were no longer assured. But automakers were accustomed to the higher profit margin on traditional gas guzzlers, and they gambled that they could milk their investments in conventional engines and drive trains rather than convert to more efficient products. As usual, the cost of that mistake to the workers and the economy as a whole was far greater than the cost to the corporation or its management.

Thus, our society's capacity to exploit the results of scientific and technological inquiry lags far behind the productive potential of these disciplines. To put it another way, the real problem of technological innovation is that its contribution is totally controlled by what we in the machinists' union have come to call the "corporate state." That phrase connotes the tremendous success of the corporate sector in harnessing our public institutions to private corporate ends. But it also connotes the corporate control of the total resource base — not only raw materials and direct production labor, but the intellectual and scientific communities as well.

I believe most of the members of the scientific and technical communities think of their work as contributing to general social progress. But I also fear that too many men and women of goodwill find their efforts increasingly constrained by a corporate state that has managed to tighten its grip on the results of R&D, so that researchers serve primarily to advance narrow corporate interests. These interests are not necessarily compatible with what is needed to strengthen our economy and society. Necessity may still be the mother of invention, but in our economy, necessity without cold cash goes unrecognized. And scientific and technical expertise devoted to the needs of the economically disenfranchised — workers, the unemployed, retirees — goes unrewarded.

We can no longer afford the inefficiencies of economic concentration and corporate control of innovation; it is time to reassert the public interest. The question before scientists, engineers, and those concerned with technological progress is whether its potential is to be harnessed to the enhancement of human life and social welfare or to its degradation. □

We welcome contributions from our readers to Forum and Special Report. Queries should be submitted to the Forum editor, Technology Review, Room 10-140, M.I.T., Cambridge, MA 02139.

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Don Bolander, B.S., M.A., Litt.D.;
Director of the Memory Training Institute

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Controlled Release: A New Approach to Drug Delivery

by Robert Langer

Tiny time pills were only the beginning. New technologies provide users with the ultimate in long-term chemical-dispensing systems that will save not only time and money but also improve the quality of life.

EVERY day, millions of people take drugs in the form of pills, shots, drops, and ointments. Every day, huge quantities of pesticides are sprayed on our lands and in our waters. Both processes must be repeated at regular intervals to maintain effective drug levels, an inconvenient and sometimes dangerous process.

In the 1940s and 1950s, "sustained" release of these compounds was achieved through formulations that slowed but did not control drug delivery, such as in so-called tiny time pills. By combining medications with less soluble substances, coating them with materials that did not dissolve in stomach acid, compressing them into dense tablets, or putting them into suspensions or emulsions, we could cause them to be effective longer. However, the amount and rate of drug release was strongly influenced by patient-to-patient variations and other environmental effects, and repeated administration remained necessary.

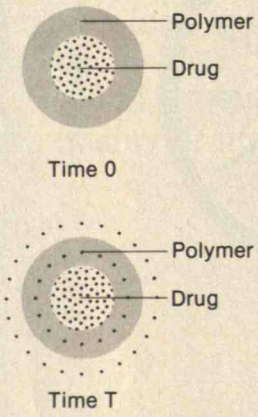
It was not until the 1960s that a method of controlled release was developed. By embedding drugs in a piece of plastic or polymer, scientists have been able to prolong their gradual release for up to a full year. By varying the polymer used, they could also control the rate at which the drug dispenses.

Types of Controlled-Release Systems

Polymers release drugs by four general mechanisms: diffusion, chemicals, swelling, and magnetic processes. The most common mechanism is diffusion through plastic, whereby the drug migrates from its initial position in the plastic to the outer surface. Slowing the rate of diffusion within the plastic can decrease the rate of delivery to the body.

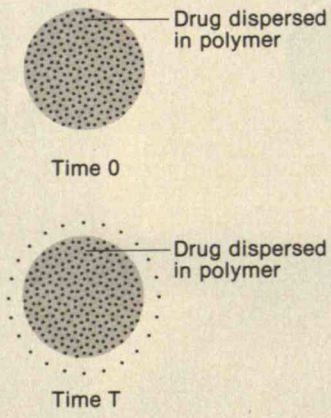
Two types of diffusion-controlled systems have been developed: the reservoir and the matrix. In the former, a core of drug is surrounded by a plastic film.

Idealized diagram of the cross-section of a spherical diffusion-controlled membrane-enclosed reservoir drug-delivery system. In this system, a core of drug is surrounded by a polymer, and diffusion is controlled by the type of polymer used, most commonly silicone rubber or ethylene-vinyl acetate.



Examples include capsules, microcapsules, tubes such as hollow fibers, and membrane systems. In the matrix or monolithic system, the drug is distributed uniformly throughout the plastic.

Idealized cross-section of a spherical diffusion-controlled matrix system with dispersed drug. The medication is distributed uniformly throughout a plastic, from which it is released at a rate dependent on the amount of drug present.



Examples include polyethylene and polyvinylchloride films such as those used in two of the first applications of slow-release technology: the Shell No-Pest Strip and flea collars.

The principal advantage of the reservoir system is the ease with which constant release rates can be obtained. If we imagine a core of drug surrounded by two rectangular membranes, and assume that the release will occur only through these membranes, the release rates are directly proportional to the area of the membrane and the difference in drug concentration between its inside and outside walls. To maintain a steady release rate, the drug concentration at the inside wall must be kept constant. This can be done simply by placing the drug at a concentration far above its solubility (in powdered form) between the membranes. As water diffuses through the membrane, a small amount of the powdered drug dissolves. Soon the concentration equals the drug's solubility and an equilibrium is maintained between soluble and insoluble drug. As long as powdered drug is present inside the membrane, this process will continue, and the release rate will not change.

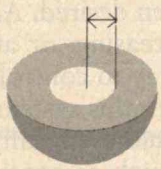
Because constant release is generally desirable, reservoir systems are often the method of choice. However, they have several disadvantages: They are not biodegradable; therefore, implants placed under the skin must be removed by making a small incision. They are potentially dangerous because a tear in the reservoir could cause the rapid release of all the incorporated drug. Finally, it is expensive and difficult to manufacture membranes that will cause slow diffusion of drugs of larger molecular weight, such as polysaccharides, enzymes, antibodies, antigens, and other proteins. Thus, reservoir systems are most useful for long-term delivery of drugs of small molecular size, such as a variety of over-the-counter preparations.

The principal advantages of matrix systems are their low price and relative safety in case of leakage. In addition, appropriate incorporation of drugs in plastic matrices causes the formation of a series of tortuous interconnecting pores that can permit continuous release of drugs of very large molecular size such as insulin, enzymes, and antibodies for over 100 days. The principal disadvantages of matrix systems are that they are not biodegradable and that they generally do not release drugs at constant rates. The latter is due to the fact that in conventional matrix systems such as slabs or spheres, the drug is re-

leased from the surface first and has only a short distance to travel. Later, when the drug from deeper within the matrix is released, it has a greater distance and therefore longer time to travel. Thus, release rates from matrix systems generally decrease with time.

One way to achieve constant release rates is to compensate for the increased diffusional distance with an increased area of drug. Matrices in the form of hemispheres are coated with an impermeable barrier, except for a small concavity in the center face from which the drug is released.

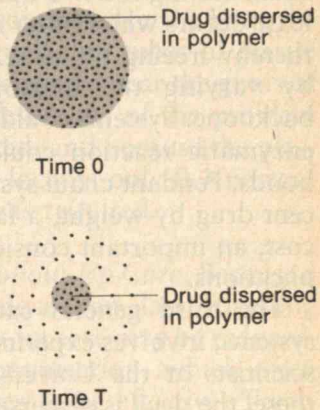
Matrix drug-delivery system, in which the drug is encased in a hemisphere of impermeable material. Because release of the drug is possible only through the small exposed section, the release time is less variable than with other matrix systems.



This can be envisioned as a small cantelope cut in half, where the orange pulp of the melon is the drug itself. The melon half is coated everywhere except where the seeds were. In this way, all of the drug is released through the small exposed section. Although the drug must travel increased distances at a later time, more surface area of drug is then available.

The next general category of release methods is chemically controlled systems, where the rate of drug release is maintained by a chemical reaction with the plastic. The two systems of chemical control work by very different mechanisms. In the bioerodible system, the drug is distributed relatively uniformly throughout the plastic as in matrix systems, but it differs from the matrix in that its plastic portion decreases with time. As the plastic surrounding the drug is eroded, the drug escapes. This property offers a significant advantage over nonerodible systems because bioerodible polymers are eventually absorbed by the body, obviating the need for surgical removal. However, this advantage must be weighed against the possibility that the absorption products may be toxic, immunogenic, or carcinogenic. The most popular bioerodible polymers have been absorbable suture materials such as polylactic acid. However, many other plastics are currently being tested.

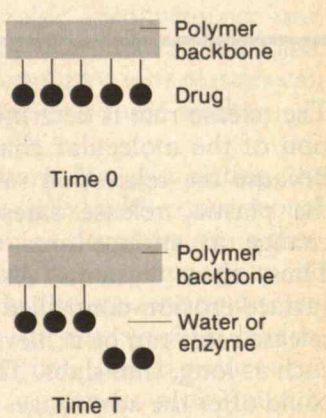
Bioerodible matrix in which the drug is (ideally) distributed uniformly throughout and released by diffusion. The system degrades and is absorbed by the body, obviating the need for surgical removal.



In practice, release from bioerodible systems may occur by a combination of erosion and diffusion. However, if the release rate is solely determined by the erosion of the plastic surface, release will depend on the remaining surface area of the implant. Thus, to obtain constant release, a geometrical shape such as a long, thin slab would be necessary, where the surface area did not change with time.

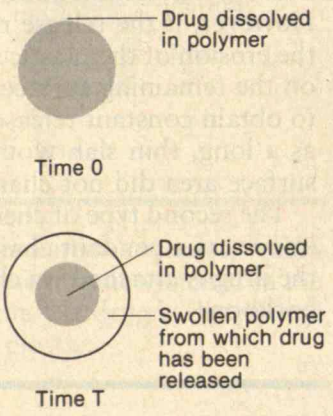
The second type of chemically controlled system is known as a pendant chain system. In simplest form, the drug is attached via chemical bonds to a polymer backbone.

Chemically controlled pendent chain drug-delivery system. Here, the drug is bound to a polymer backbone and released by hydolytic or enzymatic cleavage, the key to controlling the medication's delivery. Though still in the development stage, this system shows great promise because of its versatility and ability to carry a large percentage of drug by weight.



It could also be attached via a spacer group, a sort of chain linking the two but not affecting function. Release occurs when water reacts to break those bonds, thereby freeing the drug. Release rates are adjusted by varying the hydrophilicity of the polymer backbone. Systems could also be designed so that an enzymatic reaction could break the drug-polymer bonds. Pendant chain systems can carry over 80 percent drug by weight, a factor that could help lower cost, an important consideration in agricultural applications.

The third general category, swelling-controlled systems, involves experimental devices developed by scientists at the University of North Carolina. In these, the drug is dispersed in the plastic as in matrices. However, here the drug is locked into place by surrounding molecular chains of polymer. Upon exposure to environmental fluid, the outer region of the plastic begins to swell, allowing the drug to diffuse outward.



Cross-section of a swelling-controlled matrix. Drug is dissolved or otherwise dispersed in this system but is not able to diffuse through the polymer matrix. Environmental fluid is imbibed by the system, causing it to swell and eventually to allow diffusion of the drug through the swelled sections. The release rate is determined by the speed with which ambient fluid enters the system.

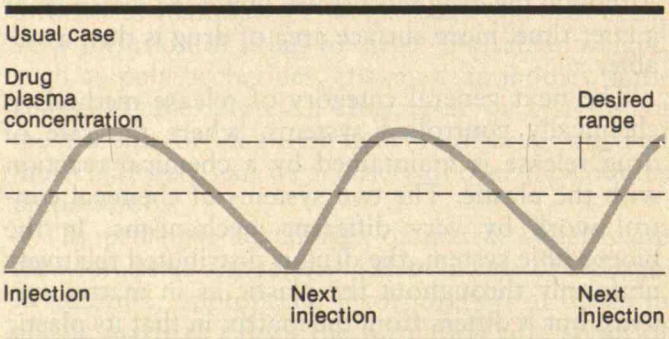
The release rate is determined by the rate of relaxation of the molecular chains that unlock the drug. Because the relaxation rate is constant throughout the plastic, release rates are determined by the change in surface area throughout the implant. Thus, these systems display kinetics similar to surface-erosion-controlled implants, and constant release rates can be achieved using geometric shapes such as long, thin slabs. This design, once perfected, could offer the advantages of both reservoir and matrix systems. It is relatively simple to obtain constant release rates using the swelling matrix, and because the drug distribution is uniform, the system can be made simply and quickly.

In magnetically controlled systems, the final technique, drug and magnetic beads are uniformly distributed within a solid plastic matrix. Upon exposure to environmental fluid, the drug is released in a fashion typical of matrix systems. However, the drug is released at a much higher rate in the presence of an oscillating magnetic field. The mechanism responsible for this effect is unclear. The oscillating magnetic field may cause alternate compression and expansion of the pores formed by the incorporation of the drug, thus facilitating release.

The principal advantage of magnetically controlled systems is that increased release rates can be obtained when desired. All the other systems deliver drugs at decreasing, or at best constant, rates, and there is no way to control these once release has begun. Although this system is still in an early stage of testing, it could eventually be used in small triggering devices such as special watches carried by patients to regulate drug delivery.

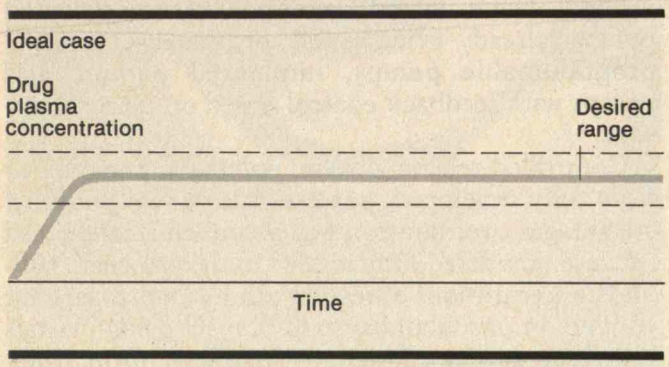
Clinical Advantages

Maintenance of Drugs at Therapeutic Levels. Each time a person takes medicine, the drug level in the blood rises, peaks, then declines, eventually almost to zero.



Plasma drug levels as a function of time for the usual case of drug administration. In the usual case, such as an injection or the taking of a pill, the plasma drug level reaches a peak as the drug enters the bloodstream. The drug is quickly cleared and falls to a low level, necessitating repeated administration. When the drug is above the desired range, it may cause unwanted side effects; when below this range, it may not be effective.

Since each drug has a therapeutic range above which it is toxic and below which it is ineffective, oscillating drug levels may cause alternating periods of ineffectiveness and toxicity. While tiny time capsules or other sustained-release preparations have succeeded in attenuating the peaks and valleys, they have not eliminated them. In contrast, a controlled-release preparation can maintain the drug in the desired therapeutic range by means of a single dose.



Plasma drug levels as a function of time for the ideal case of drug administration. In the ideal case, a controlled-release system maintains the plasma drug level at the desired range for periods of up to a year.

Localized Drug Administration. Most drugs are taken orally or otherwise migrate throughout the entire body to reach their site of action. This often requires a high systemic dose to achieve the necessary local dose. With controlled-release implants, a continuous local level of drug can be maintained without distribution to other tissues or organs, where it could cause harm.

Such localization is currently being studied for birth-control drugs. Many women take progesterone, but because the drug is administered orally, only a small portion of the dose ultimately reaches the target organ — the uterus. Small plastic implants containing progesterone that can be inserted into or near the uterus have been developed. These implants release the drug for over a year and can achieve the same local dose at one-thousandth the conventional oral dose. Any side effects caused by progesterone presumably would be greatly reduced with lower systemic levels of the drug. (*See "New Directions in Contraception" by Carol C. Korenbrot, November/December, page 52.*)

Controlled-release implants have also been used to deliver drugs locally in the treatment of periodontal disease. The normal treatment involves oral administration of an antibiotic, tetracycline, for several weeks. In a study recently conducted at the Forsythe Dental Clinic in Boston, small thin tubes of plastic containing tetracycline were placed near the gums of patients. All clinical manifestations of the problem were subsequently eliminated, and because the plastic tubes released the drug locally, only 0.1 percent of the conventional dose was required.

Reducing the Need for Follow-Up Care. Because a single controlled-release dose can last for long periods, the need for follow-up care may be reduced. A good example is in immunization, which often takes three or more dosages to be effective. Treatment for allergies may require a regimen of weekly shots for up to five years. Developing countries and poor areas of the United States often lack facilities for follow-up care, and controlled-release technology could lessen this problem. For example, animal studies recently conducted at M.I.T. and the Children's Hospital Medical Center in Boston have shown that small injectable plastics containing vaccines can act as a continuous series of minishots. High antibody titres have been produced with a single shot.

Preserving Volatile Medications. Some drugs are rapidly metabolized by the body and therefore must be given in high quantities and multiple doses. Controlled-release systems could protect the drug from degradation and allow it to be continuously released in unaltered form. For example, interferon, a new and very expensive antiviral drug, is quickly destroyed once it enters the bloodstream. Effective therapy with interferon is likely to require repeated administration at considerable inconvenience and expense. Recent studies in our laboratories have shown that interferon incorporated into plastics can be released continuously for over three weeks.

Increased Patient Comfort. By eliminating the high initial drug levels associated with conventional dosage forms, and maintaining drug levels in a therapeutically desired range, we can minimize pain and side effects. For example, in the conventional treatment for glaucoma, one of the world's leading causes of blindness, pilocarpine (which reduces eye pressure) is administered four times a day in eyedrops. These eyedrops can be painful and the high

A particularly intriguing development is artificial tears.

initial dose may cause side effects such as double vision. ALZA Corp. in Palo Alto, Calif. has developed a controlled-release system for pilocarpine. Known as the Occusert, it consists of a thin sandwich with the drug in the center surrounded by a layer of plastic. The Occusert can deliver pilocarpine continuously at a near-constant rate for one week when placed in the lower part of the eye, where it floats in the tear film (*see the photo on page 33*). The system can control intraocular pressure and results in fewer side effects than the eyedrop method.

Improved Patient Compliance. When a schedule of drug dosage is required as therapy, patient compliance is often a problem. However, this problem is obviated with controlled-release therapy. Thus, one important application of controlled-release technology could be in rehabilitation programs for drug addicts. Narcotic antagonists used to cause an aversion to addictive drugs are short-lived and require frequent administration. Recently, DYNATECH Corp. in Cambridge, Mass. and several other corporations have developed injectable and biodegradable plastic materials that release narcotic antagonists for at least 50 days. These systems have been effective in primates and are awaiting clinical trial.

Decreased Expense and Waste. In many situations, high initial drug doses are given because of possible loss through degradation or inefficiency. Thus, the total amount of drug utilized, and the total cost, is greater. Controlled-release systems could potentially decrease both cost and waste, particularly significant in agricultural products. For example, pesticides and fertilizers are integral to the production of 60 percent of the total U.S. food crop. Unfortunately, these chemicals can cause serious contamination, and standard methods for administration such as spraying result in a great deal of waste. Also, experiments show that controlled-release procedures can reduce the necessary dosage of antifouling agents on ships by a factor of 12, certain molluscicides (used to kill water-borne parasites) by a factor of 30, and aquatic herbicides by varying but substantial quantities.

New Medical Applications

An area of considerable importance for the application of controlled-release technology is the treatment of diabetes. Diabetics normally require insulin injections once or twice daily. In addition to being inconvenient, this schedule results in abnormal peaks and valleys in blood glucose levels. Some clinicians feel that poor control of blood glucose may be responsible for diabetic complications such as blindness and heart and kidney disease.

Over the past few years, a number of pump systems have been developed for improved delivery of insulin. These include external battery-powered pumps (already being tested on humans), external programmable pumps, implanted pumps, and pumps with feedback control based on glucose sensors.

Controlled-release insulin polymers, though far from fully developed, possess at least two potential advantages over pumps: they are much smaller, and because powdered drug is used in the polymer, 100-fold concentrations of insulin can be loaded per unit volume. In our laboratory, insulin-releasing plastics have been developed that are capable of normalizing blood glucose levels in diabetic rats for at least one month per single implant. Magnetically controlled release systems could increase insulin delivery at desired times, such as after a meal.

A particularly intriguing development is artificial tears. A number of people have inadequate ocular lubrication, with no particularly effective method of treatment. Recently, a bioerodible plastic was developed that can be placed in the lower eyelid. The plastic slowly dissolves over a one-day period, providing continuous lubrication and tear-film stability in the eye. This system is expected to be commercially available this year.

Another development concerns the use of scopolamine in preventing and treating nausea induced by motion or chemotherapy. The drug is normally given orally or intramuscularly, resulting in peak-and-valley drug levels in the blood and undesirable side effects. Recently a plastic scopolamine delivery system has been developed that reduces these side effects while delivering the medication over a three-day period. With a contact adhesive on the front side, the reservoir device does not need to be implanted but can be placed directly on the skin. Such transdermal delivery is important not only because of its ease of administration but because of its ability to localize the drug simply. Because the skin is one of the most impenetrable tissues of the body, it is not usually considered a suitable

The Occusert slow-release insert placed in a patient's eye eliminates the need for eyedrops in the treatment of glaucoma and other ocular diseases. The insert, which floats in the tear film, releases pilocarpine (which reduces intraocular pressure) at a constant rate for up to a week.

portal for drugs to enter systemic circulation. However, for drugs such as scopolamine, with its small therapeutic index and high skin permeability, the advantages of skin as a route for drug administration are clear. The scopolamine system has already been approved by the Food and Drug Administration, and a number of other transdermal systems are being tested.

Other controlled-release systems being studied and tested include fluoride-releasing plastics for prevention of dental caries and systems for the release of anticoagulants or antimalarial drugs. The variety of systems in these and other applications will undoubtedly continue to grow.

Pest-Control Applications

Controlled-release systems have actually had a far-greater impact on agriculture than on the pharmaceutical industry. One example is a capsule designed by the Pennwalt Corp. to hold 0.01 grams of the insecticide diazinon, a powerful roach killer. The capsules are diluted with water and can be sprayed with conventional equipment. The ability of these capsules to release diazinon continuously at a relatively slow rate not only increases the drug's efficiency but reduces its oral and dermal toxicity to mammals.

A second agricultural application is in pheromones, volatile nontoxic sex attractants used to trap insects. While several methods for controlled release of pheromones have been developed, the most widely used is the Hercon polymeric dispenser, a three-layer plastic laminate (reservoir system), with the pheromone in the inner layer and plastic barriers on either side (usually acrylic, polyvinyl chloride, or Mylar). A pressure-sensitive adhesive can also be incorporated for ease of application. When the dispenser is exposed, the pheromone diffuses continuously through the plastic in a manner similar to the way it is excreted from an insect to lure its mate. The release rate can be controlled by adjusting the area of the dispenser, the amount of drug loaded, or the thickness of the plastic. The pheromone is emitted at a constant rate, generally for four months. While encapsulated in the polymer, the pheromone is protected from degradation by air and light. An efficient and inexpensive means of trapping undesirable insects, Hercon dispensers have been used effectively against gypsy moths, boll weevils, and bollworms.

Another potentially important application of controlled-release technology is in antifoulants, chemicals that prevent the attachment and growth of organisms on ships. It has been estimated that the increase in fuel consumption from the effect of fouling on hull drag of all navy ships costs more than 150 million dollars per year. Antifouling paints leach out a pesticide, but large amounts of the chemical are released in initial phases and the coating of toxin is depleted. A controlled-release organometallic polymer system was developed, with a polymer backbone composed of acrylic, urethane, epoxy, polyester, or polybutadene. These polymers are chemically linked to a metallic pesticide such as copper, tin, arsenic, or mercury salts. Field tests with organometallic tin polymers have shown 100 percent resistance to all forms of fouling for four years.

Another example concerns the control of parastic disease, a critical health problem in tropical nations. The major snail-borne disease, schistosomiasis, strikes up to 300 million people per year, with several million deaths annually attributed directly or

One important application of controlled-release technology could be in rehabilitation programs for drug addicts.

indirectly to it. The disease is caused by a free-swimming larva, the cercaria, which is asexually reproduced in the snail. Released into freshwater, it easily penetrates the skin. The penetrant travels via the circulatory system to folds around the liver, spleen, and bladder, where it develops into an adult worm. Paired male and female worms continuously produce large numbers of eggs. Though most of the eggs are secreted from the body, many are trapped in capillaries and various organs, causing tissue damage and lowered resistance to disease.

The conventional approach to schistosomiasis control is through the use of chemical agents called molluscicides, which interrupt the parasite transmission cycle by destroying the intermediate snail host. The major molluscicides are copper sulfate, niclosamide, trifenmorph, and pentachlorophenols, usually applied as powders, solutions, or emulsions. However, these techniques require frequent application, are very expensive, and are often ineffective. Over the past few years, several controlled-release molluscicides have been developed such as the INTRACIDE E-51 system, which can be added directly to the affected water. It is an ethylene-propylene-diene rubber base containing copper sulfate, which slowly leaches out. This system has proven effective in controlling molluscs for over a year, and because it requires much less drug, the impact on nontarget biota is lessened. The cost is also considerably less, an important factor for the underprivileged nations in which they are used.

Some of the controlled-release pesticides used effectively in agricultural applications can also be employed in the home, in fly strips and "insectapes" to kill roaches, for example. Polymeric systems may also be useful in food technology to retain flavor or nutrients. In air fresheners, fragrances are incorporated into polymers and slowly released into the household atmosphere. Since cost is a primary concern in household products, inexpensive polymers and fabrication procedures are more critical than precisely controlled release rates.

Future Prospects

Research on medically related controlled-release systems increased considerably in the 1970s. Yet clinical applications have not made as significant an impact as other applications, partly because such products must undergo extensive clinical trials and receive approval from the Food and Drug Administration. The implants must be reasonably priced, safe, relatively painless, free from leaks, and accepted as viable alternatives to conventional therapy by both physicians and patients.

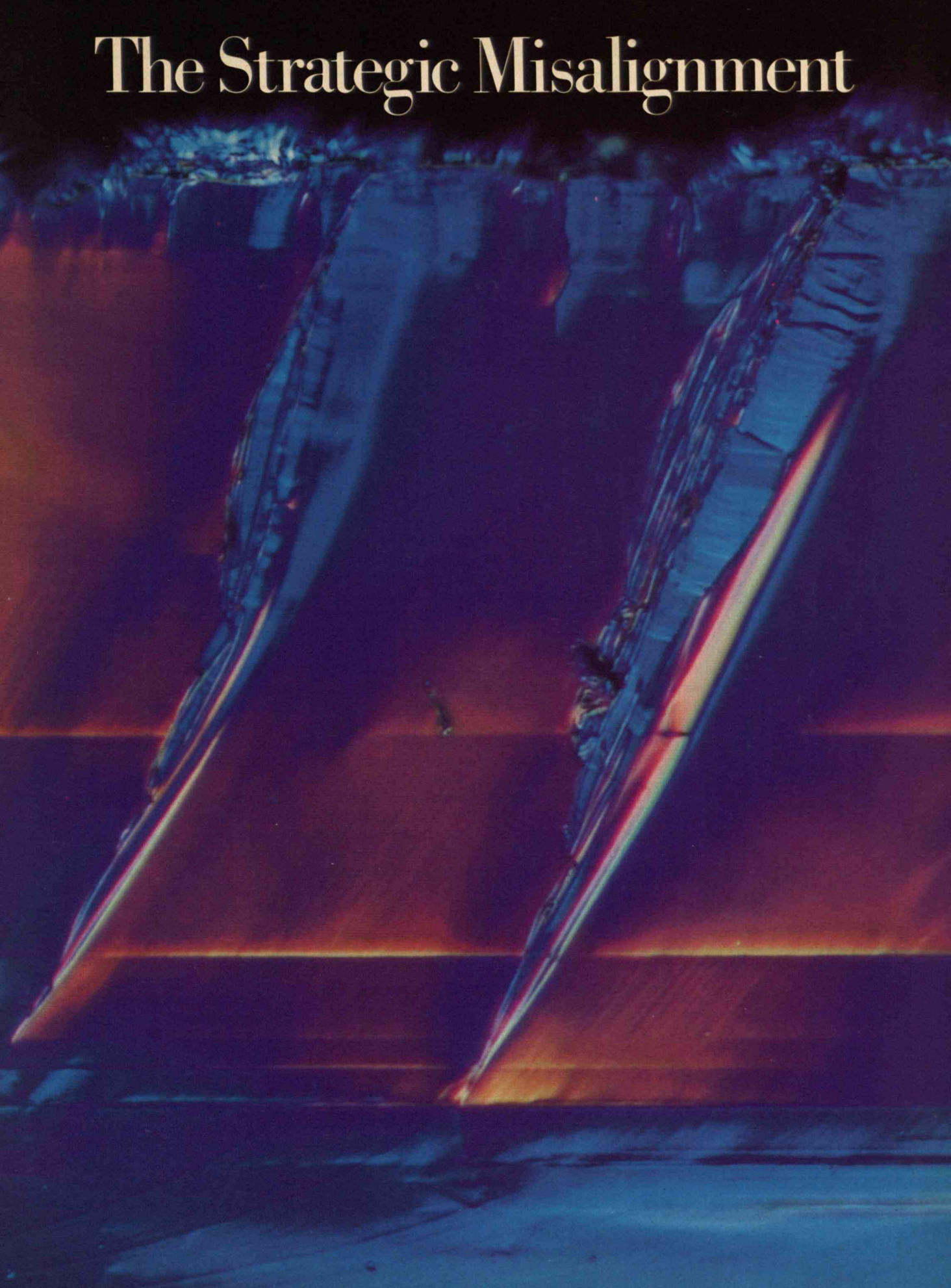
Many research efforts are underway to develop new controlled-release drug-delivery systems. One of the most important yet least studied is oral systems. A recent development is a membrane that encloses a drug and a salt. The drug does not diffuse through the membrane; rather, water from the outside is attracted to the salt and imbibed. The water volumetrically pumps out the drug through a small laser-drilled hole. The membrane surrounding the drug is semipermeable so that it transports water through the membrane at the desired rate while being relatively impermeable to the drug and salt.

Another important area is the targeting of drugs to specific cells or organs. In a number of studies, drugs have been encapsulated in small fatty vesicles called liposomes, or coupled to polymers or antibodies. These systems can be designed so that certain cells (such as cancer cells) could take up the drug more readily. Such an approach could greatly minimize systemic toxicity.

Only a few clinical controlled-release systems have received approval from the Food and Drug Administration. But because the potential advantages of controlled-release technologies are great, they will likely have considerable impact on future drug development.

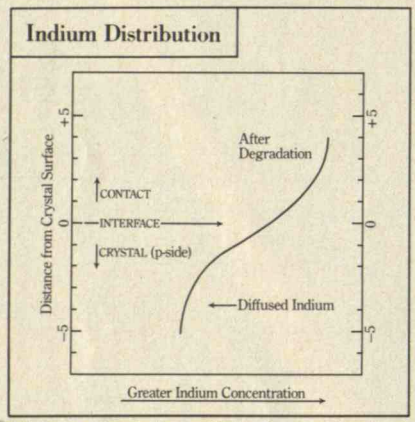
Robert Langer is assistant professor of biochemical engineering at M.I.T. A specialist in drug-delivery systems, he is presently coediting *Medical Applications of Controlled-Release Technology* (CRC Press, forthcoming).

The Strategic Misalignment



The Strategic Misalignment

Tunable semiconductor lasers can now measure specific gases in automotive exhaust with 25-millisecond response time. A successful strategy for improving laser reliability developed at the General Motors Research Laboratories makes this and other new spectroscopy capabilities practical realities.



Electron microprobe analysis of a crystal-contact interface, indicating indium penetration into the PbSnTe crystal.

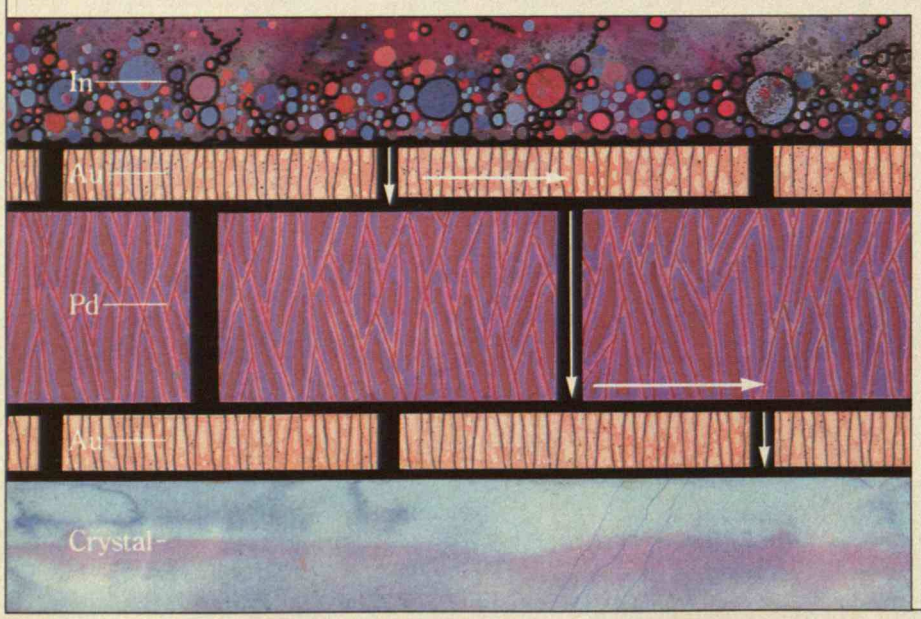


Diagram of hypothetical indium diffusion paths for a three-layer contact structure of Au-Pd-Au.

THE ACHIEVEMENT of long lifetime and frequency stability makes the lead-tin-telluride diode laser a practical infrared spectrometer. Earlier innovations brought to this laser the characteristics of increased power, higher temperature operation, greater efficiency and wider tuning range.

Operating in the 5- to 10-micron range, the PbSnTe laser spectrometer can resolve the time-dependent emission of carbon monoxide, sulfuric acid vapor, methane and other species of interest in automotive exhaust. This permits measurement of transients in carbon monoxide to carbon dioxide gas conversion in a catalytic converter. This capability represents a significant advance over conventional spectroscopy instrumentation. The laser is also being tested by NASA for use in detecting the molecular species involved in chemical reactions in the stratosphere.

New knowledge of the process by which laser reliability is compromised has been revealed in fundamental studies conducted by Dr. Wayne Lo and his colleagues at General Motors. Dr. Lo's investigations have demonstrated that laser lifetime and stability are limited by the development of excessive electrical contact resistance. He has been able to stop increases in resistance by devising a multilayer ohmic contact consisting of different metal films. This configuration has extended laser operating lifetime to more than 1,000 hours and increased shelf-life to an estimated 25 years.

Slow degradation due to a gradual increase in contact resistance was observed in idle lasers stored at room temperature, but not in lasers maintained at a maximum temperature of 77 K, despite several hundred hours of continuous operation. These results suggested the temperature-dependent process of diffusion.

Degradation occurred primarily on the p-type side of the laser, where the contact consisted of a thin layer of gold followed by a

layer of indium. Electron microprobe analyses revealed that indium, a semiconductor donor, was diffusing through the gold layer into the crystal, apparently causing a reduction in hole carrier concentration near the p-surface. This effect was counteracted to a great degree by sandwiching a thin layer of platinum between the layers of indium and gold. Laser reliability reached a full year.

When degradation was still observed, although to a reduced extent, Dr. Lo advanced the hypothesis that diffusion and transport were taking place along grain boundaries in the polycrystalline contact layers. He proposed replacing the Pt-Au barrier with a three-layer structure. Since palladium film structures have fewer grain boundaries than those of platinum, providing fewer leakage paths for the indium, Pd was tested in place of Pt.

DIODE LASERS composed of $Pb_{0.86}Sn_{0.14}Te$ and fabricated with a variety of contacts were maintained at 60°C in order to accelerate aging, with periodic interruptions for testing. The results showed that a multilayer structure of In-Au-Pd-Au, in which the grain boundaries tend to be misaligned, provides maximal reduction of indium penetration, confirming Dr. Lo's hypothesis.

The misaligned boundaries force diffusion to take place laterally, which slows transport into the crystal. The additional layer slows the process even further.

Solving the contact problem represents the culmination of efforts that began at General Motors with the development of an "ingot-nucleation" vapor transport method for growing crystals. The resulting crystals are of high purity, with a dislocation density of less than 1000 cm^{-2}. Lasers made from these crystals incorporate a low temperature cadmium-diffused p-n junction. This process, invented by Dr. Lo, increases the laser's output to five milliwatts.

A tuning range of 500 cm^{-1} and pulsed operating temperatures of up to 140 K are achieved by a two-step annealing process. This technique induces a graded carrier concentration that increases infrared light confinement in the laser structure, thus reducing losses and increasing output.

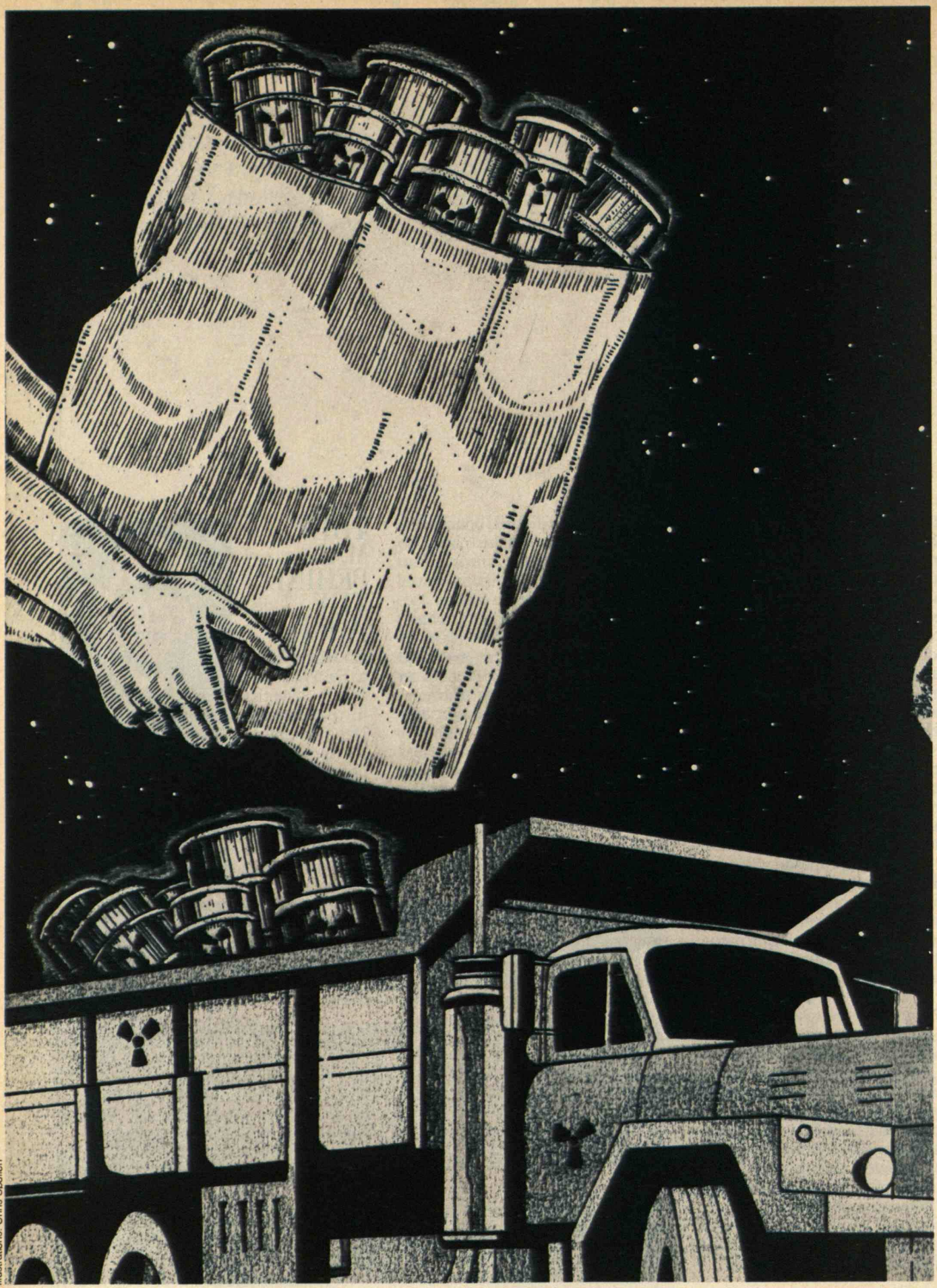
"These innovations," says Dr. Lo, "combine to produce a laser that allows us to make measurements previously impossible."

THE MAN BEHIND THE WORK

Dr. Wayne Lo is a Senior Research Scientist in the Physics Department at the General Motors Research Laboratories.

Dr. Lo was born in Hupei, China. He did his undergraduate work at Cheng-Kung University in Taiwan. He received an M.S. from the University of Rhode Island and a Ph. D. in electrical engineering from Columbia University in 1972. His doctoral thesis concerned the characterization of deep-level states and carrier lifetimes in gallium arsenide light-emitting diodes.

Before undertaking graduate studies, Dr. Lo was instrumental in setting up the first American transistor production plant in Taiwan. In 1973, he joined General Motors, where he is currently in charge of semiconductor laser and spectroscopy research.



Illustrations: Chris Spollen

Systems concepts embracing several options for immobilizing, containing, and interring wastes from nuclear weapons and reactors are now ready. But unresolved sociopolitical issues demand new educational efforts.

The Technology of Nuclear-Waste Management

by Rustum Roy

RADIOACTIVE residues from nuclear fuel used in reactors have accumulated in the United States from civilian power generation and from the extraction of uranium and plutonium isotopes for military weapons manufacture. In the U.S. today, these materials occur in two forms: spent fuel rods from reactors, and radioactive slurries with relatively low concentrations of radioactive elements from military operations.

After one or two years' use in a nuclear reactor, the fuel elements become depleted in uranium. Such intensely radioactive fuel bundles, partly "burnt up" and replaced by fresh fuel, are "spent fuel," a material with a highly ambiguous status in the U.S. today. No nuclear engineer considers spent fuel waste, since it contains substantial fuel values of uranium and plutonium. However, since April 1977, it has been U.S. policy that spent fuel is a waste to be permanently disposed of, because of the possibility that plutonium purified in reprocessing could be illegally directed to nuclear weapons. This policy is unique to the U.S.; most other nations embrace the reprocessing of spent fuel for recovery of its uranium and plutonium. Until this policy is truly resolved in this country, there cannot be a permanent solution to our spent-fuel problem.

For now, U.S. commercial spent fuel — about 6,000 tons in all, with 2,000 tons added every year — is stored in pools of water alongside some 70 commercial power reactors throughout the country. If and when reprocessing is authorized, uranium and plutonium will be extracted from this material for reuse in nuclear reactors. The residue will consist of a solution containing some 40 or more radioactive isotopes, or radionuclides, the disposition of which has been a subject of intense technical and political dialogue for at least two decades. Some reprocessing was conducted at West Valley, N.Y., in the 1960s, and about 600,000 gallons of waste from these operations are now in storage at that site.

With waste from the military nuclear program, the story is very different. For 30 years, the U.S. has been accumulating enormous volumes of dirty but relatively dilute slurries containing wastes from the purification of uranium and plutonium used in weapons research and production.

Some 70 to 80 million gallons of these materials are stored in large steel tanks in isolated areas of federal reserves near Richland, Wash., Savannah River, S.C., and Idaho Falls, Idaho. They are relatively weak in radioactivity because they have decayed for 30 years on average and because large

The finding that glass lacks integrity led to two fundamental changes in radioactive-waste-disposal concepts.

amounts of neutralizing oxides have been added. Both these factors reduce the concentration of the radioactivity and hence the temperatures generated in storage from radioactive decay. Nearly half the radioactive material in these defense wastes has already been solidified into relatively poor ceramic materials that are now doubly encased in corrosion-resistant metal canisters. Though the volume of defense wastes is vastly larger than that of the 6,000 tons of spent fuel, the latter contain more radioactivity. However, this relationship may be changed by a new program, still controversial and not yet executed, to manufacture a substantial amount of additional plutonium for military purposes.

Current Approaches to Waste Management

Despite the fact that it is virtually impossible for nuclear wastes as they are now handled to expose large numbers of people to dangerously high levels of radioactivity, such "interim" storage systems are inadequate for long-term disposal of radioactive waste (or radwaste, as it is often called). But progress toward a more complete and permanent isolation has been plagued by procrastination, technical neglect, and sociopolitical constraints.

The Atomic Energy Commission virtually ignored research in waste handling during the 1950s and 1960s. The disposal plan then proposed for wastes from reprocessed nuclear-reactor fuel involved storing the liquid waste for 10 years, solidifying it into a silicate glass to form cylinders 12 inches in diameter and 10 feet long contained in stainless-steel jackets, and either storing it at the earth's surface for 100 years or isolating it permanently by burying it in a salt-mine repository. The presence of salt was seen as assurance that water that might dissolve or transport the waste was not present, and the heat generated by the radioactivity would in any case cause the containers and salt to fuse into an impregnable unit. Indeed, the waste canisters were expected to attain temperatures of up to 500° C for perhaps 100 years, with the design temperature of the cannister in salt set at 350° C. This procedure would also have involved an enormous amount of transportation, since the candidate salt beds were in the Southwest and most of the radwastes in the East.

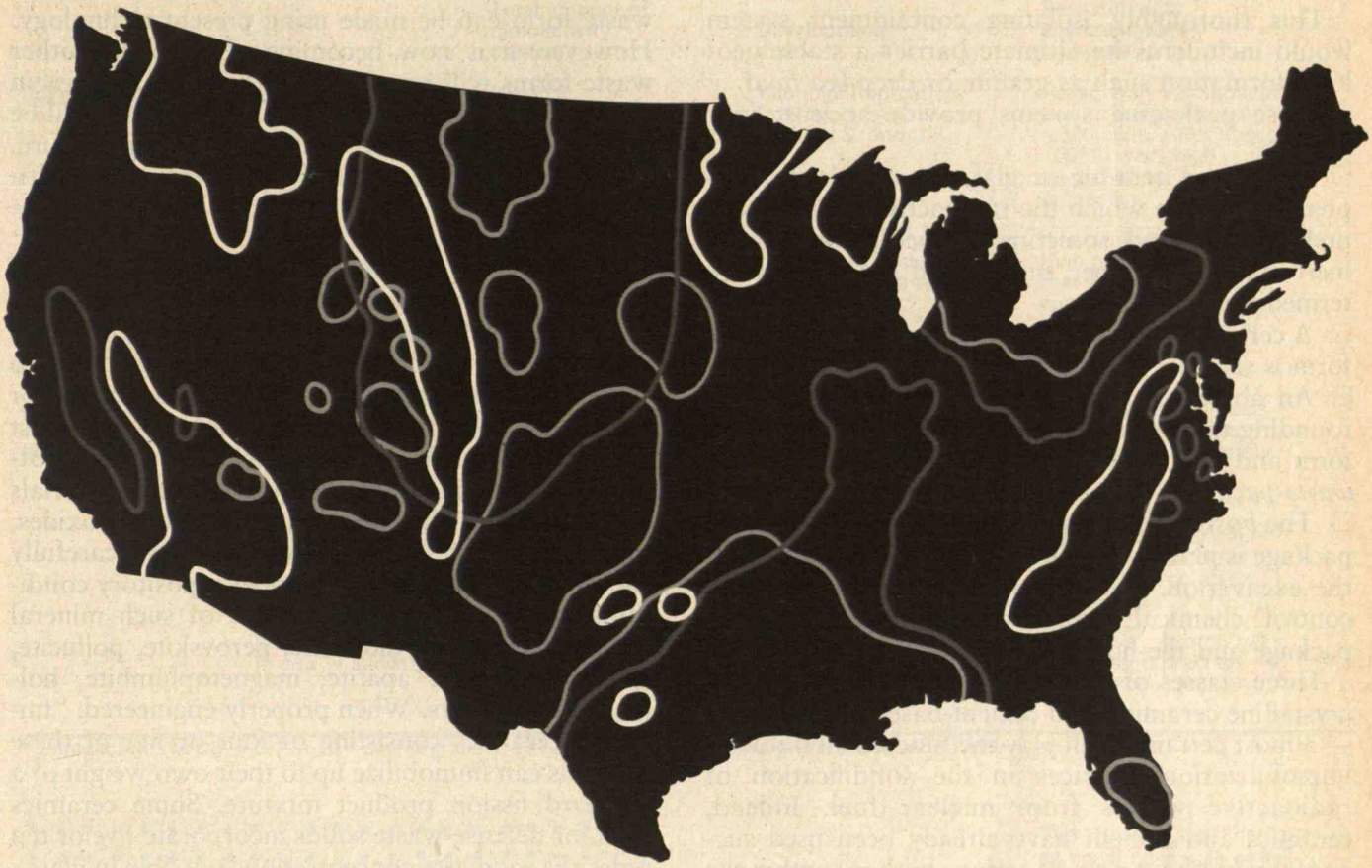
But in 1978, glass was found to lack structural integrity under such conditions. Samples of typical glasses proposed for radwaste encapsulation in the United States reacted in the author's laboratory in a matter of days in the presence of water at temperatures as low as 250° C. (The same team told the Atomic Energy Commission in 1973 that they strongly suspected this reactivity, but they clouded the impact of this finding by speculating that the reaction products in some kinds of host rock could be crystalline minerals more stable than the glass itself.) The finding led to two fundamental changes in thinking about the system of radioactive-waste disposal: First, the insolubility of the waste matrix became an equal partner with the isolation by the host rock in assuring the safety of the final repository system. Second, the design temperature for the waste form was lowered substantially.

Beyond the Reference Concept

With these two elements of the system in place, what kind of total radwaste-disposal system can we ultimately adopt? By storing high-level, undiluted radwastes for an extended period of time before disposal, France and Sweden have opted for a major advantage in another element: storage of wastes for 40 to 50 years prior or subsequent to processing. There are very significant technical advantages to this programmed storage: the radioactivity, and therefore the capacity for heat generation of spent fuel, is reduced by one to two orders of magnitude during the first 40 to 50 years after it is removed from a nuclear reactor. According to these plans, storage will be followed by containment of the aged wastes and geologic isolation in various rock types.

In the past year or two, U.S. strategy for managing the wastes that result from nuclear power generation has come to embrace the concept of a system: storage, solidification, encapsulation, and burial, partly by default and partly by plan. Aging has become the first step in this system more because of political than technological constraints — there is simply no likelihood of agreement on further solidification and isolation of U.S. nuclear fuel wastes within the next decade. Indeed, storage for 40 to 50 years before or after reprocessing is a virtual certainty for most wastes now existing in the U.S.

A deliberate determination to make such interim storage part of our waste-disposal system would have important benefits and few costs. The principal cost would be to ensure the availability of additional



- Granite and volcanic rocks
- Rock salt deposits
- Shale and clay formations

The search for geologic environments in which to store treated radioactive wastes focused first on salt formations. It was thought that such formations would assure the long-term absence of water, and that the heat generated by radioactive decay would fuse salt and wastes into an impermeable mass. The integrity of salt formations has recently been questioned. Attention has turned to hard media — granitic and basaltic rocks — and shale and clay formations in the hope that storage sites can be found in many locations to minimize the transport of wastes throughout the U.S.

facilities to increase surface storage capacity using technologies that have been successful during the past 40 years. No new technology and a minimum of research and development — involving shielded shipping casks, improved fuel racks, and the mitigation of minor accidents in storage pools — would be needed. Establishment and announcement of this storage as policy would, in addition, require regulatory and political action on licensing and transportation. After 40 to 50 years of storage, with radioactivity and therefore capacity for generating heat significantly reduced, spent reactor fuel and liquid reprocessing wastes could be even more easily handled for permanent immobilization and isolation.

A Significant Strategic Change: Enter the "Russian Doll"

As noted, the fundamental strategy for the permanent disposal of radioactive wastes from reactor fuel has recently undergone significant change. Confidence in geologic isolation has decreased, while confidence in the effectiveness of carefully engineered waste packages has grown. Such waste packages consist of systems that enclose radwastes in extremely impermeable, chemically resistant solids and then surround these "radiophases" with additional redundant barriers — a layered system that has been likened to the Russian Matryoskha dolls.

A four-layered "Russian doll": waste form, canister, waste package, and host rock.

This thoroughly isolating containment system would include as its ultimate barrier a stable geologic formation such as granite or deep-sea mud.

These packaging systems provide at least four barriers:

☐ Inert solid ceramic or glassy materials ("radiophases") within which the radioactive waste is securely immobilized, sometimes embedded in another inert matrix. Together, matrix and radiophases are termed the *waste form*.

☐ A ceramic or metallic canister in which the waste form is sealed.

☐ An absorbent mineral filling, or overpack, surrounding this canister, tailored to the specific waste form and host rock. Together, these constitute the *waste package*.

☐ The *host rock* or seabed clay in which the waste package is placed, possibly within a casing that lines the excavation. The overpack will be designed to control chemical interaction between the waste package and the host rock.

Three classes of materials — amorphous glasses, crystalline ceramics, and cement-based encapsulants — almost certainly will play the fundamental role of immobilization matrices in the solidification of radioactive wastes from nuclear fuel. Indeed, ceramics and cement have already been used successfully (without a single serious mishap) within the United States and USSR for a decade, despite impressions to the contrary among policymakers.

Glasses (noncrystalline ceramic compositions). A great deal of research on monolithic glasses of various compositions has produced a class of materials that could be mated satisfactorily with appropriate canisters and overpacks as components of a total system. It has been known for several years that some glasses have the ability to incorporate as much as 35 percent of their total weight in fission products, but the loadings now considered are in the 10 percent range.

It is now possible in the United States to mix, melt, and cast monoliths of silicate glasses up to 1.5 feet in diameter by 10 feet long. Several large cylinders of fully radioactive glass were made in England over a decade ago, and the French brought their modest glass (pilot) plant into successful operation at Marcoule in 1978. Glass became the "reference" waste form in the United States in the 1970s, and there is little question that an acceptable glassy waste form can be made using present technology. However, it is now becoming obvious that other waste forms will be as good or better than glass in terms of stability and leachability, and some will be potentially much less complex to manufacture. Simplicity and cost are likely to determine the ultimate choice.

Ceramics (crystalline materials). The survival of several specific crystalline minerals containing radionuclides through literally billons of years under repositorylike conditions is compelling evidence to support the use of ceramics as the radiophases for radioactive ions from nuclear reactors. The latest approaches include solution mixing, sintering, hot-pressing, or fusing assemblages of ceramic materials and radwastes. The ceramics, which include oxides, titanates, silicates, and phosphates, are carefully chosen for their insolubility under repository conditions, based on the performance of such mineral analogs as fluorite, monazite, perovskite, pollucite, spinel, nepheline, apatite, magnetoplumbite, hollandite and others. When properly engineered, "tailored" ceramics consisting of four or five of these minerals can immobilize up to their own weight of a standard fission product mixture. Some ceramics used for defense-waste solids incorporate five or ten times the radwaste concentrations possible in glass.

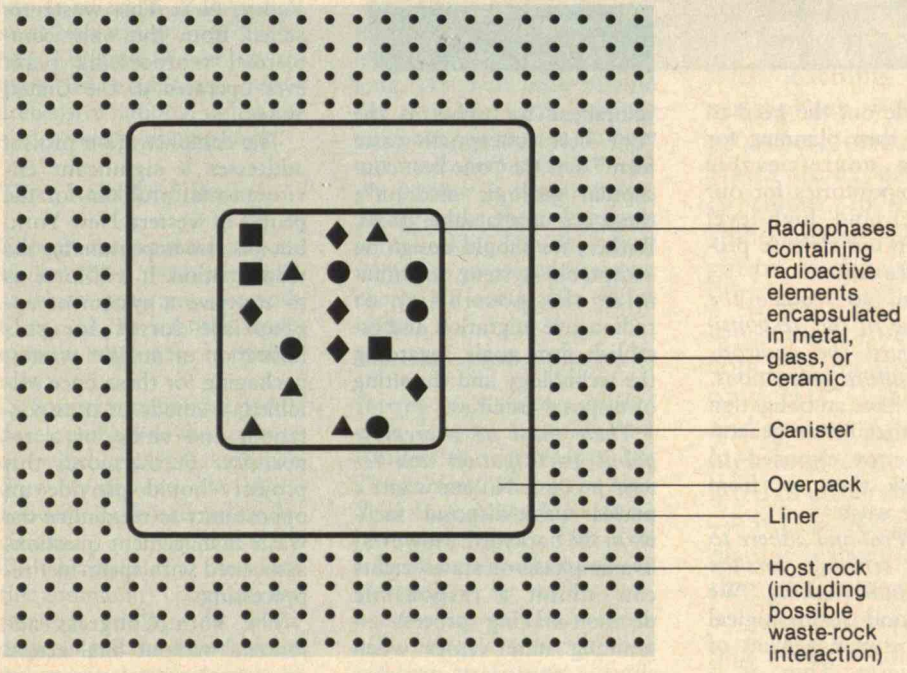
Some systems for creating radioactive-waste forms depend on chemical separation of individual long-lived radionuclides so that each can be incorporated into its own most insoluble ceramic matrix. Indeed, as noted, half the radioactivity from nuclear-weapons waste has already been partitioned for this purpose. For such single-ion wastes, ceramic waste forms are at their maximum advantage. A further improvement, bought at the price of additional process complexity, involves coating pellets of the ceramic assemblages with other inert ceramics, giving one of the most stable waste forms at high temperatures. Extraction of the radionuclides from such a compound assemblage represents a formidable problem even in a laboratory.

Encapsulating Materials. Even liquids have been encapsulated as tiny inclusions in rocks and minerals for millions of years inside the earth. Yet in the early years of the nuclear age, no one gave much thought to relying on the insolubility and impermeability of an encapsulating material. This strategy relegates

Currently functioning nuclear-waste solidification systems. At least five classes of systems are now seriously proposed for solidifying high-level radioactive waste from nuclear reactors, and most have been tested to at least the pilot-plant stage. It is virtually certain that the USSR is now using the "ceramic-inside-sandstone" system at the bottom of the chart, as has Oak Ridge National Laboratory for a decade; they will begin using a similar system on a larger scale by the end of this year. At their present dilution, all American military wastes could be inexpensively fixed into concrete waste forms for burial on-site by this system. In contrast to the glass and ceramic systems at the top of the chart, the glass, metal, and ceramic encapsulants are not radioactive; they enclose other ceramic or glassy phases that are. All these systems provide long-lasting stability in retaining radioactive ions.

		Total amount of radioactivity treated*	Development status	Research data and comments on waste form
Solidification only completed.	Glass	30 M Ci	Pilot-plant operation in France, test runs in the U.S. and U.K.	Reasonably insoluble at low temperatures but reacts with water above 100° C. Very high temperatures involved in processing.
	Ceramics	350 M Ci	Successful, fully engineered systems at Hanford Works operating for a decade.	Inherently more stable than glass; evidence is that specific minerals survive indefinitely in nature. High temperatures involved in processing.
Complete solidification and disposal	Concrete-based composites	1 M Ci	Grouting technology fully operational at Oak Ridge, Tenn.	More stable than glass at low temperatures. Major advantage is low temperature of processing.
	Lead metal matrix composites	1 M Ci	Pilot plant in Belgium.	Among the most chemically desirable forms, but involves complex processing.
	Ceramic composites *in situ* in sandstone	100+ M Ci	Successful, fully operational system in the USSR of underground pumping.	Extensive research background and practical experience.

* 1 megacurie (M Ci) = 3.7×10^{16} disintegrations per second. The numbers given are rounded estimates.



The "Russian doll" concept — so named because of its redundant layers — includes a sequential set of barriers to retain radionuclides in solid, inert phases. At the center, the waste is solidified in a radiophase of either ceramic or glass or encapsulated by ceramic, concrete, or metal. Next is a canister to protect the ceramic or glass. Then an absorbent overpack protects the canister from inbound corrosives and the environment from radioactive materials leached from the canister. Next is a liner, and finally is a host rock, originally conceived as salt, now generally expected to be salt, granite, basalt, or shale. A fifth barrier may result from chemical interaction between the host rock and the waste containers. The system includes protection at all levels — atomic (radiophase), microstructural (encapsulant), and macrostructural (canister).

A Congressional View of Managing Radioactive Waste

by Stanley N. Lundine

SUCCESSFUL implementation of a program to manage our nuclear wastes is not an insurmountable task, but certainly it is a sizeable one.

Our past efforts have been sporadic initiatives aimed at solving a problem for which a policy has yet to be developed. The Carter administration made a genuine effort toward launching a national policy on management of nuclear waste. However, the recommendations that finally emerged failed to make the policy and budgetary commitments necessary to move forward on the long-term management problem.

The United States has a convincing first-rate technical capability in the management of radioactive waste, but our application of that capability toward an acceptable long-term policy is frustrated by at least five obstacles:

We must first resolve our policy for the back end of the nuclear fuel cycle. The central question is whether we should go forward with commercial reprocessing of spent fuel and the development of breeder reactors to utilize the plutonium thus obtained. Countries that have made a decision on this issue — France, England, and Germany — are further along than we in implementing a policy of radioactive-waste management. However, what makes sense in France, England, and Germany should not be blindly accepted in the United States, which has different energy options, including vast domestic coal, oil, and natural gas resources as well as a more advanced solar capability.

If we decide that it is economical to reprocess spent fuel and pursue a breeder economy, an emphasis on on-site storage and retrievable geologic storage facilities for spent fuel makes sense. If we can rule out the need to reprocess, then planning for long-term nonretrievable geologic repositories for our spent fuel and high-level waste from our defense program makes sense.

We need to resolve the moral issue of our responsibility toward the environment and future generations. I think we have an obligation to insure that future generations are not exposed to greater risk than we from radioactive waste.

We must set and adhere to a realistic schedule for the final decision making. We have a good technological base in the management of nuclear waste. Thus, it is neither necessary nor in our best national interest to insist on endless research and development to arrive at the "one best conceptual waste form" and the "one best conceptual geologic medium"; these are unattainable goals. Rather, we should design an acceptable system to minimize the possibility of radioactive migration and establish firm goals regarding the technology and the siting of disposal facilities.

There must be a credible public participation and review process. No one wants a nuclear-waste-disposal facility in the backyard. However, overemphasis on states' rights can inhibit a responsible decision-making process — granting state vetoes when siting a repository or other disposal facility is impractical. Therefore, we must choose the best sites with meaningful public participation.

The distinction between civilian and military nuclear waste should be eliminated in their management. Both technically and politically, the answers to the civilian and military nuclear-waste problems are interlocked. Failure to establish an institutional framework to coordinate these efforts can only inhibit overall progress.

Congress: Action and Inaction

Congress must play the key role in removing these obstacles and defining the framework for a national policy on nuclear waste. The 96th Congress made a start with the enactment of legislation I sponsored authorizing the Department of Energy to solidify the radioactive liquids (nearly 600,000 gallons) at the Western New York Nuclear Service Center in West Valley, N.Y. This waste resulted from the only commercial reprocessing plant ever operated in the United States.

The demonstration project addresses a significant environmental problem for the people of western New York, but it is also important for the whole nation. It will force us to conceive a system of appropriate forms for solidification of nuclear wastes, packaging for these once solidified, methods of transportation, and siting of a repository. Furthermore, this project should provide an opportunity to reexamine the waste-management questions associated with spent-fuel reprocessing.

The 96th Congress adjourned without final action on several critical aspects of nuclear-waste policy, including a national program to develop geologic repositories.

Discussion centered around two alternatives: development of several "research-and-development" repositories or surface storage facilities as an interim step to siting permanent repositories, and establishment of a firm timetable for siting permanent repositories and development of a public participation process.

While a research-and-development repository would provide an opportunity to gather data and demonstrate state-of-the-art technologies, such a program is no substitute for a firm commitment to a permanent, licensed repository. Moreover, research-and-development repositories should not be pursued if the potential for developing long-term sites will be lost. Congress's effort to launch such a siting program fell apart over disagreement regarding the treatment of military nuclear wastes. Renewed efforts to reach a consensus must be a top priority of the new Congress if we are to have an effective, comprehensive national policy on nuclear-waste management.

Three Roles for Scientists

Though the ultimate responsibility for a national nuclear-waste program lies with Congress, the scientific community must have a major role.

☐ Scientists must continue to develop the knowledge base on which policymakers can draw to decrease the likelihood of ill-advised policy decisions.

☐ It is critical that the scientific community communicate research findings on waste disposal and the larger energy policy issues to key decision makers and the public. Because management of nuclear waste is a highly technical as well as emotional issue, it is difficult for policymakers to understand and communicate the technical issues to their constituents. For example, policymakers need to know what the problem of nuclear waste really means to the future of nuclear energy and to generations to come.

During the last Congress, I invited several scientists and policymakers from across the country to lecture and interact with the public, and advisory groups of citizens and scientists have also been formed in conjunction with the West Valley solidification project. Such efforts are critical to achieving an acceptable national nuclear-waste policy.

☐ The scientific community must act as an independent sounding board for political decision making, ensuring that political and institutional constraints do not destroy the technical integrity of the waste-management system.

We have only begun to formulate a policy for a problem that has been ignored too long. We must look beyond our own backyards, and we must not ask too few to bear too much responsibility simply because it is convenient. As we make these decisions, we are asking how far we are willing to go to make nuclear energy an acceptable energy option.

Stanley N. Lundine, trained as a lawyer at New York University, represents the Thirty-Ninth District of New York State in the U.S. House of Representatives. This essay is based on remarks made at a symposium on radioactive-waste-disposal technology and policy at the annual meeting in Toronto of the American Association for the Advancement of Science last January. ☐

the radiophase solids incorporating the radioactive atoms to a secondary role; they must be reasonably insoluble but their exact properties can be unknown.

Early work on encapsulated waste forms goes back only to the 1950s, when clay and zeolite mineral sieves were used to adsorb radionuclides. These were subsequently reacted by heating to give a mixture of reasonably insoluble radiophases encapsulated in aluminum-silicate ceramics derived from the sieve materials. But the greatest success with encapsulation has been achieved in the USSR, where natural mineral encapsulants have been used. In one experiment, essentially unknown radiophases were encapsulated in a quartz-mica host present in a micaceous sandstone rock. According to Soviet reports, extensive radiochemical monitoring of the area has shown that this technique provides adequate protection against radionuclide transport.

An encapsulating process used at Oak Ridge National Laboratory depends on both unreacted and hydrated cement mineral phases as encapsulants. Field monitoring after actual disposal shows the net insolubility of encapsulant and radiophase to be adequate. Encapsulation in ceramics and cement has been accomplished in the author's laboratory at Pennsylvania State University by hot-pressing high concentrations of fission products into quartz and various oxides, including glasses, to yield a product with leaching properties very similar to typical radiophase waste glasses. In more recent approaches, researchers in Sweden and the United States are experimenting with a titanium dioxide encapsulant. In the U.S. the alumina (sapphire) and spinel already present in the waste are under investigation as encapsulants for defense-waste sludges.

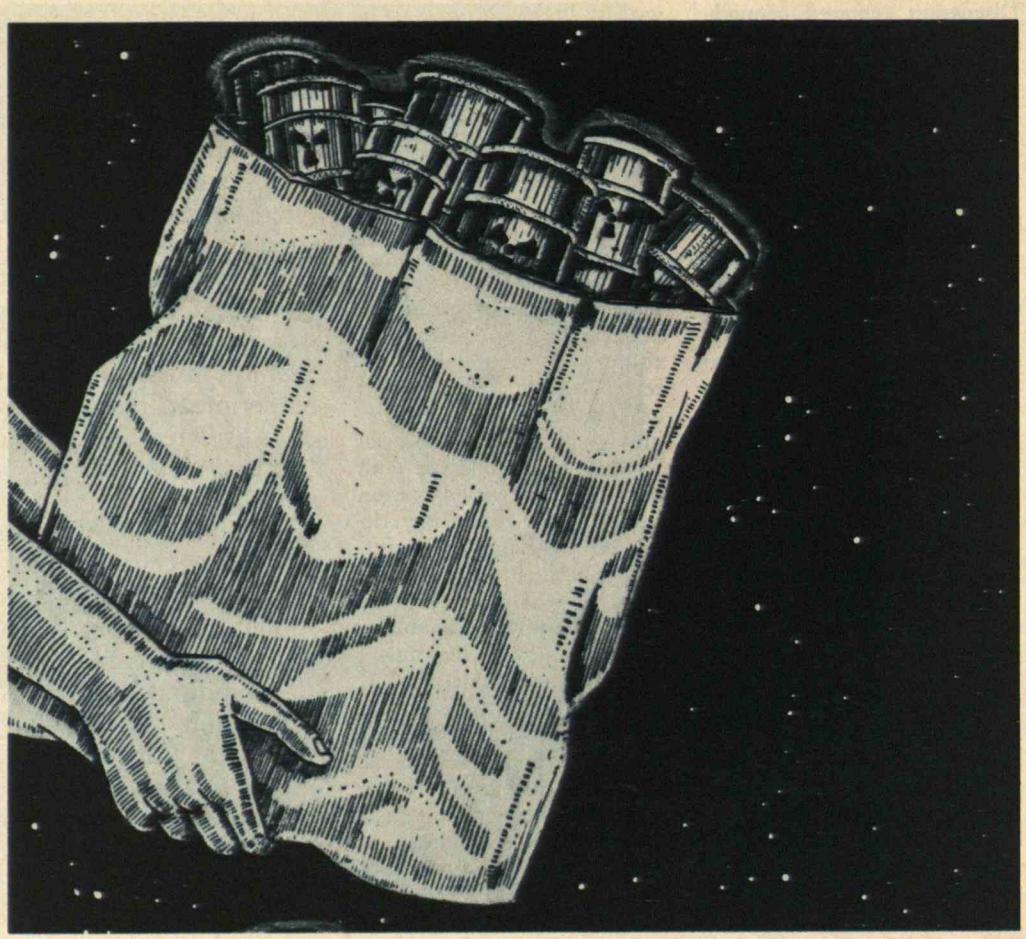
In the long term, the general acceptability of a low-temperature encapsulation process, involving a concrete encapsulant requiring temperatures up to only 250° C (compared with 1,200° C for glasses and ceramics), appears extremely likely. Already the high-level commercial and defense wastes encapsulated in concrete — large monolithic concrete blocks — at Oak Ridge have proved to resist leaching and display a thermal conductivity essentially as good as that of the best glasses. Concrete is hardly affected by temperatures of 300 to 400° C, and recent work has shown that it will not be affected by the radioactivity, an earlier concern of some scientists. Such cement encapsulation techniques offer the prospect of an enormously simplified waste-disposal

Facing Radioactive Reality: How to Get the Job Done

HERE is a scenario, based on our understanding of the technical system, for the management of radioactive military and reactor wastes as affected by scientific and political realities in the United States over the next 50 years.

In the first step of the national waste-disposal strategy, the government would acquire all spent commercial reactor fuel, with the utilities making one-time payment for reprocessing or disposal services. This fuel would be stored at the government's expense for 45 years, first at the reactor where it was produced and later at aboveground storage sites at defense-waste facilities, or possibly at sites that are candidates for permanent disposal.

With these steps taken, a decision on reprocessing or disposal of spent fuel can be made, and there can be a careful and orderly selection among waste-package and host-rock options for different wastes in different parts of the country. It is foolish for the government to select waste forms, canisters, and sites quickly when new research findings may alter optimal solutions. However, this process should be stabilized by the mid-eighties, and we can confidently expect the selection and demonstration of an optimal example of each of the four waste forms (immobilization in ceramic, glass, or concrete, and encapsulation) and burial of these pilot samples in each of the four rock types (salt, granite, shale, and basalt). Research on seabed sites may require more time. However, seabed burial offers the best technical and political solution, and commitments should await tests of this option.



Whether on land or sea, given typical time constants for the entire process, a repository could not be ready to actually receive immobilized wastes until after the year 2000 at the earliest. If a reasonable test of the efficacy of the system required at least 10 years (more probably 20), we could not be ready to close a repository filled with waste until 2025. Thus, the suggestion of urgency in disposal of nuclear waste when no urgent action is possible is counterproductive. A single exception to this, recently recognized by Congress, is the need to *solidify* (but not to dispose of) the commercial wastes at West Valley, N.Y., into a simple solid form and move them in this form to one of the major protected national nuclear establishments.

Defense Wastes

With defense wastes we confront exactly the opposite situation: commercial wastes are almost all in the form of spent reactor fuel rods awaiting a final decision on reprocessing, while there are nearly 100 million gallons of defense wastes, some of which are already 35 years old. These extremely dilute wastes consist mainly of inert oxides and average very little radioactivity per gallon.

It appears virtually certain that the final disposal of this material will be on-site, and the first major disposal effort in the United States, for four reasons:

☐ The government agencies (Departments of Defense and Energy) with jurisdiction over these wastes want to avoid lengthy hearings that call attention to this aspect of our military program. On-site disposal requires the least public debate and participation.

☐ Given the international climate and U.S. economic conditions, the government will not in the near future be willing to invest the tens of billions of dollars required to

handle these wastes in any sophisticated disposal system that may be little if any safer than the on-site option. The cost of disposal on-site could be one-tenth the total cost of solidifying, transporting, and disposing of these dilute wastes in a system designed for highly concentrated commercial wastes.

☐ The possibility that states other than South Carolina and Washington, which have already benefited from the nuclear industry, will accept a large inventory of these defense wastes — or even allow tranport across their borders — is very low.

☐ By conducting the entire disposal process on the federal land where the wastes are now stored, we could bypass many of these obstacles.

Curiously, the two on-site options for complete disposal of defense wastes have never been described in detail in any government document, and the public hardly knows of their existence. The problem is that the Department of Energy cannot propose any specific repository location without generating immediate resistance. Silence has thus been the policy of choice.

Plan, Research, and Educate

The "not in my backyard" attitude toward nuclear waste is now deeply ingrained in the United States, and only patient effort in three directions can make possible rational decisions on the management and disposal of radwaste. First, we must develop a national plan that emphasizes that there is no urgency, that we have many options, and that we can keep to a timetable in deciding among the options and executing them. Second, we must make a commitment to a modest but effective research-and-development program, with research before development and ample emphasis on engineering. And third, we need a wholly new, imaginative, aggressive program of public education.

Much of the content of the necessary national plan is implied by the accompanying article. For the research-and-development program, we must substitute for today's uncoordinated research effort by many different agencies (often performed by groups with little or no scientific experience in this field) a single technically competent institution that can marshal the best of the nation's talent.

The solution to the third problem surrounds us. A thousand American universities have programs in science and society, where interdisciplinary faculties could responsibly — yet without any outside central control — assemble and bring to their own students and to the public the facts on disposal of radioactive waste. In short order, 10,000 school systems could do the same. The cost would be nominal — perhaps a few million dollars. Indeed, this effort — under local control, with nonadvocacy groups in charge — could be a model for the education of the American public on technically complex issues.

Sooner or later, democracies must come to terms with the incompatibility of scientific elitism with the public interest. Any steps to bridge that gap will be cost-effective. The alternative — public expenditure of tens of billions of dollars on poor solutions to a relatively minor problem such as the disposal of nuclear waste — is frightening to contemplate. — *R.R.* ☐

process that could radically affect the outlook for radioactive-waste disposal. The possibility of pumping the cement slurry gives this a unique advantage in some solidification and disposal situations.

Canisters and Overpack

With the radioactive material immobilized and/or encapsulated, a so-called canister and then an overpack are to be used as the next layers of isolating material. If waste is encapsulated in cement the canister may be omitted, or it could be essentially continuous with the encapsulant, as in some metal matrix forms. But with material immobilized in a glass or ceramic radiophase, a canister is important for convenience of transport and resistance to corrosion in the chemical, heat, and pressure environment of the repository. If, for instance, a canister could be shown to assure protection for 1,000 years, then the waste form would be required only to immobilize the actinides (mainly uranium and plutonium), since all other radionuclides would decay within the 1,000-year period. Hence the importance of considering canister and waste form as a system.

For long-term service in silicate rocks, scientists naturally turn to oxide or silicate canisters or to chemically resistant metals, including stainless steel, the so-called superalloys, copper, and titanium. Of these, the Swedish advocacy of copper has received considerable support from geologists, while the French program calls for the use of canisters of a well-known alumina-zirconia ceramic to capitalize on that material's extreme chemical insolubility. However, the most remarkable canister actually produced at full scale (3 feet by 10 feet) is the hot-pressed "artificial sapphire" (Al_2O_3) canister developed in Sweden.

In the long run, concrete containers will no doubt be actively considered, especially for large volumes of waste diluted to generate low heat; concrete's extremely low cost, convenience of fabrication in situ, and ease of sealing are simply unmatchable. Most opposition to concrete canisters has been based on unfamiliarity with current concrete technology (including amateur responses based only on the familiar concrete used in highways).

The potential significance of the overpack, an additional layer of carefully engineered silicate material outside the canister, has been realized only

Expanding the options for isolation: salt, shale, basalt, granite, and deep-sea sediments.

very recently. In fact, such an overpack could fulfill two roles, acting as an absorbent (and reactant) for any ions that escape from the canister, and an absorbent for water or other materials leaking from the repository environment, thereby minimizing corrosion of the canister.

The molecular-scale engineering of overpack material has so far received very little attention. But it is clear that mixtures of zeolites, clays, and gels can be devised for maximum effectiveness with particular wastes and host rocks. The most specific overpack proposed thus far is the Swedish plan for a mixture of bentonite and quartz, which has valuable mechanical and chemical properties to resist water intrusion. However, materials with much higher absorption and retentivity of radionuclides have been developed in the author's laboratory. Because this layer is nonradioactive, it can be inexpensive to design, yet it can offer the same chemical protection as the waste form itself.

Isolation: In Land or Sea?

Assuming that packages can be engineered to contain radioactive material securely for at least 1,000 years, where and how shall these packages be interred to assure and enhance their longevity?

Just as glass dominated early thinking on the matrix for the waste package in the United States, rock salt — domed or bedded — was for many years assumed to be the ideal geologic medium for isolation. A major setback to these plans occurred when the first choice for a test site in Lyons, Kan., was found to be riddled with holes. Later, salt was found to contain more water and to be much more corrosive than previously thought and to have absorptive powers much lower than that of other rocks. Furthermore, truly unstressed salt beds were limited in occurrence.

Therefore, the last few years have brought a major change in the isolation component, as well as the waste-package component, of proposed U.S. systems of managing waste. The new approach is based on a range of options in both waste form and final isolation medium, with one tailored to fit the conditions offered or required by the other. Instead of one site and one rock type, the Department of Energy and similar agencies of the European nuclear nations are now examining sites in several additional rock types: shale, basalt, granite, and others. Computer modeling of the mechanisms by which radionuclides might move to the biosphere through such materials is being carried out, but the unavoidable uncertainties of long-range geologic predictions remain.

In the meantime, suggestions for a rather different host rock that could provide a single internationally approved solution for every nation's problem are now appearing: the use of deep-ocean-floor sediments. Detailed work by the Sandia Laboratories and the Woods Hole Oceanographic Institution shows that the top 100 feet or so of sediment on the deep ocean floor consists of highly absorptive clay materials. These seabed sites offer the world five substantial advantages as repositories:

- ☐ They would solve enormously complex sociopolitical problems associated with other repository sites in which the interests of individuals, states, and nations conflict.
- ☐ They would automatically provide another layer of highly adsorptive insoluble material in which to envelop and seal the waste container.
- ☐ Covered by 5,000 or more feet of water, they would provide a low-temperature environment with a very large capacity for absorbing waste heat.
- ☐ Isolation for millions of years is assured by the stability and age of these sediments and the absence of tectonic activity and mixing between the deep oceans and the biologically active ocean surface.
- ☐ Enormous safety is provided by the chemical shielding of sediments and dilution in seawater should any radioactive or toxic ions escape.

Disposal of Military Wastes

Wholly different and far less complex strategies seem appropriate for the large volumes of dilute wastes now held at Hanford and Savannah River. Two are especially strong contenders, though officially they are still ignored.

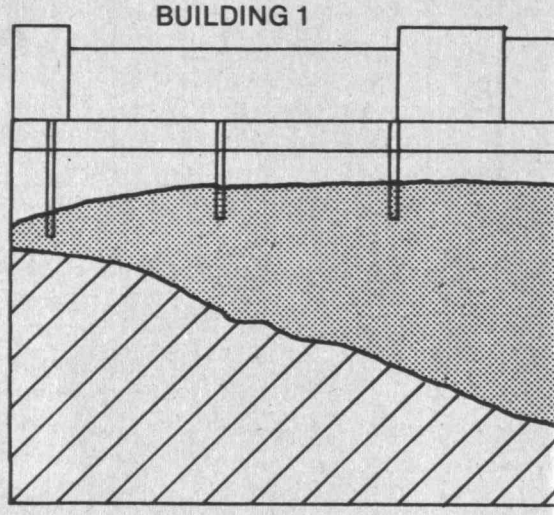
In one method — surface entombment — the wastes would be removed from the present storage tanks as fully as possible (this may be difficult, but only in this approach is thorough cleaning unnecessary), calcined to low-temperature ceramic materials with adsorptive zeolites and clays, mixed with cement, and pumped back into the tanks to solidify. The tanks themselves would then be entombed under several feet of concrete. The imperviousness of the concrete and the insolubility of the encapsulated wastes would together provide more-

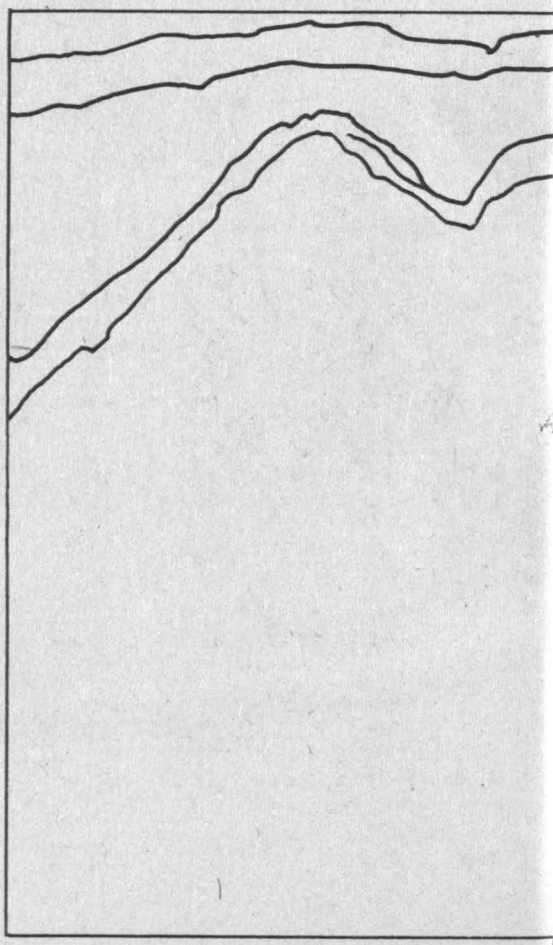
MIT

After its usual reluctance, spring is once again returning to New England — and with it comes the opening of the Sailing Pavilion and the return of dinghies to the Charles.

". . . Since their construction the Institute's main buildings have sunk as much as ten (the Great Dome) and nine (Building 2) inches — in part, according to Dr. Harl R. Aldrich Jr., '47, because of that meandering tidal stream which had washed the glacial gravel layer thin along its course."

How M.I.T. Pioneered the Mechanics of Soil While Sinking Into a Tidal Ooze





Most new sciences are born out of curiosity. But the science of soil mechanics — which came to the U.S. via M.I.T. in the 1920s — was achieved out of necessity: the Insititute's massive new buildings were sinking into the underlying ooze of Cambridge at an alarming rate.

To deal with the problem President Samuel W. Stratton called in an Austrian advocate of a new discipline called soil mechanics, Karl Terzaghi. And between 1925 and 1929, while teaching and perfecting the subject in M.I.T. classrooms, Dr. Terzaghi concluded that the rate of subsidence would gradually decrease and told Dr. Stratton that there was no cause for alarm.

That story is the highlight of a report on the foundations of M.I.T. prepared late last fall by Harl P. Aldrich, Jr., '47, president of the Alumni Association. A sticky story, as it turns out, for the foundations of M.I.T.'s new buildings, to be set on land recently a tidal flat, were a subject of controversy long before Dr. Terzaghi's arrival.

From a foundation engineer's point of view, M.I.T.'s new Cambridge location was not exactly ideal. A broad tidal flat, extending from the present river front at least half way to what is now Central Square, had been filled late in the nineteeth century, inundating among other things a small creek which had meandered through the mud from northwest to southeast, entering the Charles River itself at about the site of the Killian Court.

Bedrock in this part of Cambridge is some 130 feet down. On top of it, according to Dr. Aldrich — his degrees are in civil engineering, and he is the senior partner of a distinguished foundation engineering firm — are, in order:

☐ Ten to 17 feet of compact glacial till, deposited below the glaciers of the Pleistocene.

☐ A thick layer of inorganic "Boston clay," fine-grained, soft, plastic material deposited in the Boston Basin by streams flowing toward Massachusetts Bay.

☐ Five to 20 feet of sand and gravel laid down by later streams.

☐ An accumulation of organic silt, shells, and peat typical of tidal flats.

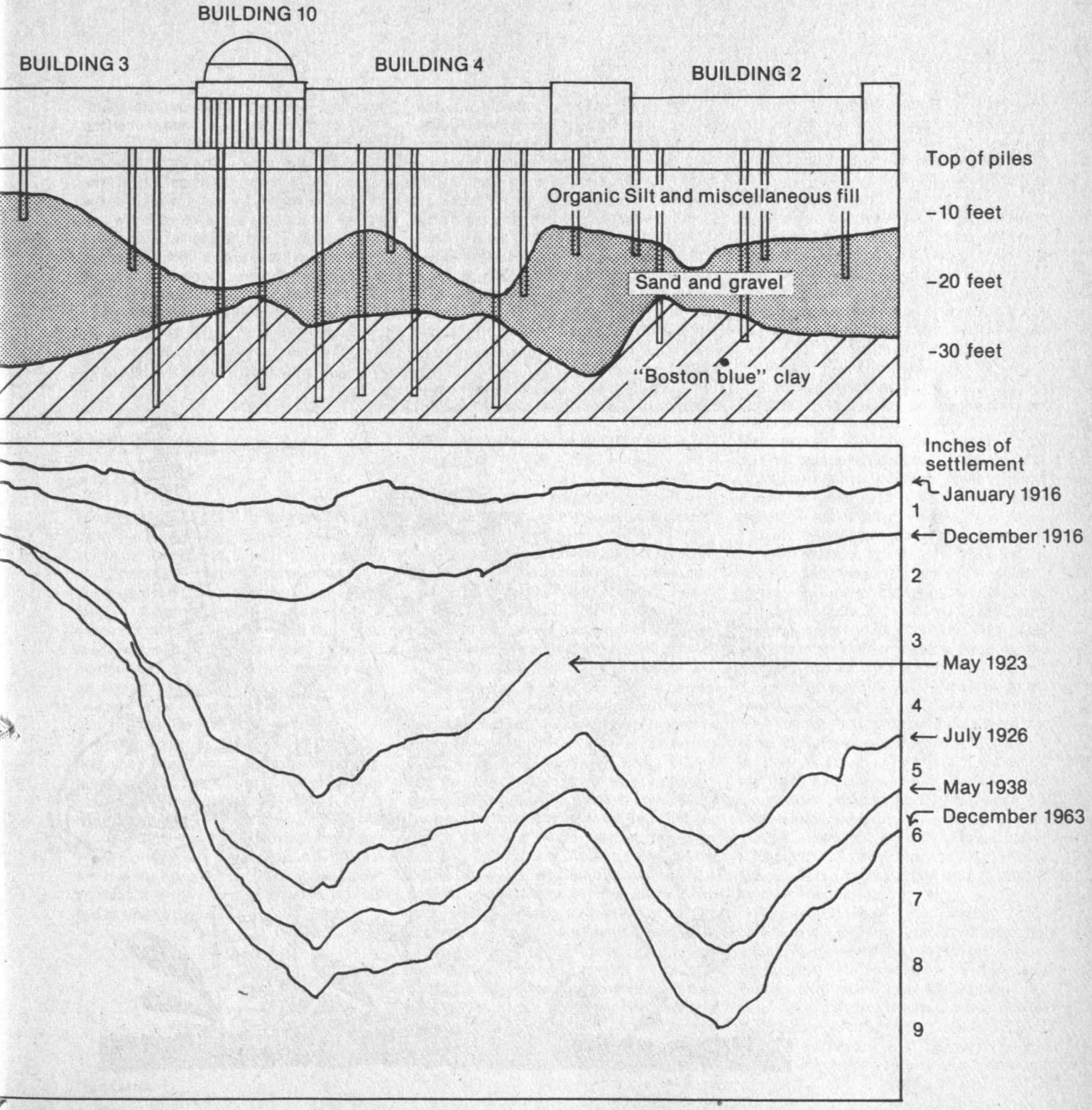
☐ Ten feet of nineteenth-century fill — rocks, soil, and junk.

Nine Inches Lower Than We Used to Be

As the planning for M.I.T.'s new buildings began, then-President Richard C. Maclaurin asked John R. Freeman, '76, a consulting engineer formerly on the faculty, to study the problem. Mr. Freeman observed that the land and buildings surrounding the M.I.T. site were subsiding — the result, he concluded, of the weight of the new fill squeezing water out of the "Boston clay."

That judgment was challenged by Mr.

The foundations of M.I.T.'s main buildings and their settlement histories. Three soil formations which underlie the Institute's site on the Charles River are shown: "Boston blue" clay, a soft plastic material formed in a marine environment; sand and gravel, the coarse-grained outwash of post-glacial streams; soft organic silt with shells; and miscellaneous fill deposited when the erstwhile tidal flats and salt marsh were reclaimed for urban use. The sand-and-gravel layer had been thinned in places by the erosion of a small stream. The Institute's main buildings were erected on a forest of word piles (only a few are indicated in the drawing below), most of which terminated in the sand gravel layer; longer piles, reaching into the clay, were used under heavy parts of the buildings and where the gravel layer was thin. This foundation was planned to capitalize on what its designers assumed was the stability of the clay. But within a year there were alarming settlements – as much as two inches – as the clay consolidated under its new load, and the stage was set for a new understanding of soil mechanics, says Harl P. Aldrich, Jr., '47, in his chronicle of M.I.T.'s underground history.



"The final design load was between nine and ten tons per pile . . . and the engineering estimate was that settlement would be no more than ¼ inch.

"General alarm, then, when settlements of as much as two inches, causing cracks in the floors, were found even before construction was complete, and even more when settlement continued at a slowly decreasing rate . . ."

Freeman's classmate William O. Crosby, '76, professor of geology, who concluded — erroneously, as it turned out — that the subsidence was simply consolidation of organic materials beneath the new fill.

Professor Crosby won out, and a third classmate, Charles T. Main, '76, engineered foundations for the new buildings to be erected on some 25,000 wood piles bearing on the sand and gravel layer above the "Boston clay." It was an immense construction project — one of the largest in the country to that time: 1.5 million board feet of lumber, 5,000 tons of steel, 15 million bricks, 450 carloads of Indiana limestone. The final design load was between nine and ten tons per pile — nominal, says Dr. Aldrich — and the engineering estimate was that settlement would be no more than l/4 inch.

General alarm, then, when settlements of as much as two inches, causing cracks in the floors, were found even before construction was complete, and even more when settlement continued at a slowly decreasing rate into the 1920s. Indeed, since their construction the Institute's main buildings have sunk as much as ten (the Great Dome) and nine (Building 2) inches — in part, according to Dr. Aldrich, because of that meandering tidal stream which had washed the glacial gravel layer thin along its course.

Everyone involved, says Dr. Aldrich, was suddenly aware of the "failure of the engineering — the need for a new understanding of soil mechanics," and soon enough the stage was set for Dr. Terzaghi.

The principal error in the story, says Dr. Aldrich, was in failing to understand that the subsidence would occur in the clay, below the foundations, as the piles were loaded; and, especially, the failure to understand the effect of a mass of piles compared to the single piles that were tested. Since longer piles were not then economically feasible, Mr. Freeman's solution would have been better: a "floating," rigid foundation of beams to spread their load equally over the buildings' entire area, thinks Dr. Aldrich.

Jon McIntosh

Elizabeth Margutti, assistant science librarian, demonstrated weaving techniques at the Libraries' Crafts Display and Workshop during IAP Spinners, embroiderers, weavers, quilters and other campus artisans participated. (Photo: Calvin Campbell)

IAP Potpourri in January

What happens at M.I.T. in January? Everything. It's a month devoted to "independent activities," which is a way of saying to everyone: it's a chance to do your thing, for yourself and your community; a chance to teach and learn and grow on your terms; a chance to share ideas for which there's no room in the crowded, pressured technical curriculum. Can you devise a way to catch an egg dropped from the third balcony of Lobby 7 without breaking it? Can you and your friends win the College Bowl by answering more obscure questions than anyone else? Would you be interested in learning computer programming languages, or building your own experiment with a lathe, a milling machine, a drill press, and a band saw? Would you like to hear Professor Philip Morrison talk about "how to travel faster than the speed of light and other impossibilities"? In the following columns you will find a small sample of IAP.

Christopher Lydon on Politics and Television

He perched on the edge of the desk, legs crossed, talking easily and articulately. Christopher Lydon, award-winning nightly news commentator on Channel 2, Boston, discussed the role of television in politics:

TV dominates the political news media, he told the audience. The whole game of politics is to *get* that spot on the television nightly news, to contrive scenes for a 10- or 20-second exposure. "It strikes me that almost everything about our politics comes out of that," he said. "Issues of life and death and bread and butter all get mediated through this game."

I realized when covering Jimmy Carter that *he* realized the game was a *casting* problem — how to grow in the imagination of people who make decisions on TV. He had a kookie mother, children, and an eccentric brother. There was a TV story in the Jimmy Carter rise — and almost nothing else — not policies or substance. Russell Baker, *New York Times* columnist, said when Carter was in the first cycle of floundering, if the Carter administration was a TV program, it would have been cancelled by now.

But Carter understood show biz and role playing, Mr. Lydon suggested. He was in a dilemma in the summer of '79; Teddy was clobbering him in the polls, the energy crisis saw no resolve. Then the shah came into the country, and in the ensuing events he had his chance to play commander in chief, Jimmy-gets-tough. It worked brilliantly for a number of months. But eventually the material wears out on any TV series.

About Carter's defeat:

"I feel enormously relieved," said Mr. Lydon. "I think there were many instances of unhealthy intimacy between Carter's promotion and others in the media. Carter was the *creation* of the media world: *Time* using him in ads for *Time* magazine, for instance, when he was an unknown."

Tom Wicker, *New York Times* columist, was wrestling with his endorsement of Carter — he felt he was the first decent Southerner to come along. Anthony Lewis, also a columist for the *New York Times*, in his first testimony to Carter, said he had stayed in Cambridge with him, and Carter made his own bed. "My experience with Carter was that he ingratiated himself with me," said Mr. Lydon. The general pattern, particularly among Southern reporters, was a sense that this was our guy.

President Reagan has a healthy arm's length between the president and the media; particularly *The New York Times, Washington Post* nexus, Mr. Lydon said. Rather than being contemptuous of the media, Reagan has a sense of his side of the street. He doesn't care what *The New York Times* says. There is a sense of distance — a sense that he had communicated

over a much longer period to the mass constituency about government; that he has a relationship with the masses that, good or bad, is not pure hype, and not media-concocted. "It's reassuring, to me, to have a candidate with a record of administration," Lydon said. "I think Reagan is not quite as shameless in avoiding being judged on performance."

A question from a student: Should we be concerned about a decision-making process that is based not on specific complex issues but on emotions?

Democracy is always a wild and crazy gamble, answered Mr. Lydon, and it's always going to be emotional and irrational, subject to abuse and danger. But people in their idiot wisdom *do* apprehend something in these visual images that is arguably sound. TV has reduced the corruption of *other* modes of communication; it is more immediate and accessible. "I like the guy's looks; he looks all right to me." As crazy as that is, it seems to Mr. Lydon that the issues are not read, that democratic judgments are made like that.— *M.L.*

The Superintendent's Memories of the Hottest Seat in Town

Robert C. Wood, who taught economics and urban affairs at M.I.T. before becoming president of the University of Massachusetts and then Boston's superintendent of schools, is back at the Institute as visiting professor of political science; and he chose an IAP seminar to make his first public statement since his firing last August by the Boston School Committee.

The multitude of constituencies and special interests entrenched in the Boston school system reduced his job to "a series of necessary and inconclusive activities that . . . closely resembled the dance of a cat on a hot tin roof," Professor Wood said of his job as superintendent.

Now, he thinks, there are only five options to restore Boston's schools to independence and professional competence: court receivership, state receivership, district representation on the elected school committee, control by the mayor of Boston, or control by a board of trustees chosen from among the constituencies.

Without some such change, Professor Wood said, the Boston school system will be "nibbled to death," despite the "professionalism that runs strong throughout the department."

Look Who's in the Living Room: Impact of New Video Technologies

The average child sits glued to the TV for 29 to 33 hours per week. And the hours of watching are going up, Peggy Charren, founder of Action for Children's Television (ACT) told a group during IAP. A voice in the audience spoke up: "One of the first things that my daughter said was 'We'll be right back after these messages . . .' "

In 1968 Ms. Charren began ACT in her living room, to increase what is available to children on television and to avoid the abuse in ads directed at children. ACT wanted to widen, not reduce, the options. Children's TV should be a public responsibility, said Ms. Charren. Across the country there are 15,000 members of ACT who agree.

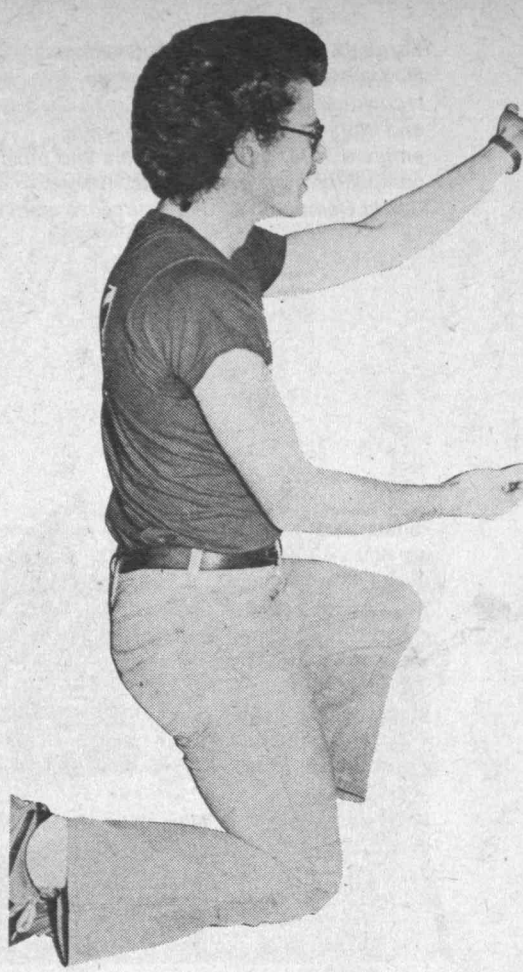
They see two primary problems: insufficient diversity in programming, and commercial messages which assure children that they need sugar foods and expensive toys to be happy and to have friends.

Cable television has myriad possibilities: programs to explain answers to math problems, services for the elderly to connect them with others, an access channel for adolescents, suggested Ms. Charren. But some research shows that people are not ready to buy something unless they are accustomed to paying for it. Movies or sports fit into that category; educational TV for children does not. They think that should be free, she explained.

"I'd rather not have cable TV advertising, but the idea is gaining momentum," explained Ms. Charren. People will pay for cable television *with* advertising. Children don't complain — the ads are usually the best-produced part of the hour.

Networks say they're only interested in "nice" commercials, not sugar products, but that's what companies want to sell to children. They don't sell books.

Ms. Charren suggested alternatives to combat the lure of television: for the little ones, leave crayons and toys in front of the TV so they turn away from the screen. And a more drastic version: when an apartment building is designed, it could include a place for the "5:00 hour," when parents are cooking dinner. Then children, instead of staring alone in front of the tube, could play together with a trained supervisor. — M.L.



This page: The Incredible Egg Drop Contest: design a device to catch an unprotected free-falling egg.

Opposite page: the longest game. The brothers and pledges of Alpha Delta Phi attempted to break the basketball marathon record during IAP. They were able to complete 43 of the 90 hours needed before fatigue, injuries, and boredom forced them to stop. (Photos: James C. Mihori, '83)

Opposite page, bottom: IAP seminar on close up magic. (Photo: Calvin Campbell)

Jerome Wiesner on Arms Control: How Can We Seize our Destiny?

"Always try to put yourself in the shoes of who you are dealing with," Jerome Wiesner, formerly president who is now Institute Professor, told a capacity audience assembled to hear him speak on arms control. Excerpts:

The two sides have different positions and different worries because of geographic situations and many other factors. We can't do serious work in this field unless we're prepared to see the military balance from both sides.

During the 1960s when I was involved in trying to negotiate agreements, weapons were so unreliable, that whenever we made a test it didn't run. My advice was we shouldn't *do* much testing or we'd frighten ourselves to death.

Weapons have now become better, smaller, and easier to hide; every stage of new weaponry makes the dangers to both sides greater. It's clearly more difficult today to monitor the situation than in the 1960s.

I believe deterrence is the only role of nuclear weapons, and it doesn't take many to do that. It doesn't matter how equivalent our stength. (Twenty largest cities, wiped out with 20 weapons, and the enemy would be pretty deterred, he said.) The first few weapons are the most effective — they would hit population centers. We can agree to reduce the numbers and it won't matter; they only important thing is to be sure a deterrent result survives. If the enemy sees that your force is larger and adds to theirs by a factor of five, it really doesn't matter. Is it a win if only 70 million Americans are killed and 90 million Russians? There would no winners. We'd be back in the Stone Age.

It's a loop that's causing trouble: we do things, predict what they're doing, and they hear us. An electrical engineering person would call it positive feedback in the system. We almost had "stop" agreements, then someone invented a new weapon and killed it.

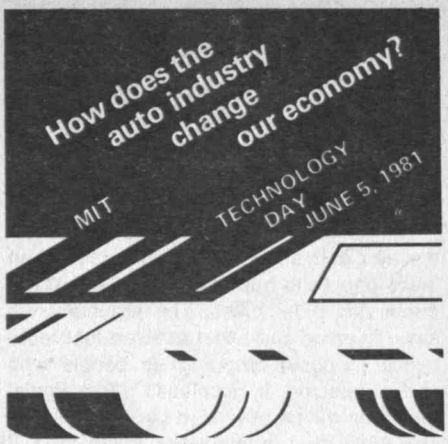
SALT is a sensitive negotiation. Any arms-limitation agreement that requires both sides to build up weapons has something fundamentally wrong with it. But we convinced ourselves that it was better than nothing: at least it had a ceiling.

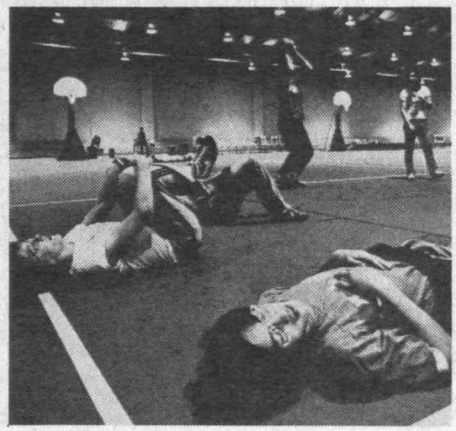
It's very clear that supplying large numbers of nuclear weapons to people we are supposed to defend is very dangerous. The Iran situation could have been worse, he said, if Middle East strife had become a test of United States vs. Soviet weapons.

What should you and I do? he asked the audience. I've found — in my judgment — it's easier to get agreement *before* research and development on new weapons. Once there is an investment, its hard to stop. We should look for new military technologies and stop them in the embryo stage.

Most important is the question of building a grass-roots constituency that is well informed. I don't know how to do that; I leave it to you. Not that there haven't been hundred of articles on the effects of nuclear war and the total inadequacy of our medical system. But we seem numb, convinced that it is in the hands of the Russians. I don't think we can blame the arms race on them; we have been equally involved.

We need a continuing public discussion. If a major share of the public believe that it's inevitable, that we have to do it because the enemy does it, than we all feel hopeless. And it's that hopeless feeling that makes people look the other way rather than try to control their destiny. We can build a constituency by saying we can moderate the future — let's see if we can lead a *peace* race. — *M.L.*





Dr. Samuel Proctor Tells the Story of Montgomery, Alabama

Montgomery, Ala. in 1955: the right place and the right time for a test of black civil rights, and the story belongs in the annals of history, like Moses leading his people. We've got to tell the story over and over, said Dr. Samuel Proctor, senior minister of the Abyssinian Baptist Church in New York City, and Martin Luther King Professor at Rutgers University. He spoke to a large audience assembled in honor of Dr. Martin Luther King, Jr., telling the story again:

There were no civil rights, but a level of trust. It was a time of strange contradictions: inside the house, the trusted maid had full charge. But as soon as she stepped into the street, she had no responsibility and no trust. Blacks knew exactly what the parameters were.

White people had convinced blacks that the situation was livible. Montgomery, Ala., had seen eight years of benign neglect. But Dr. Martin Luther King, Jr., was the right man, and the time and place were ripe to transform Montgomery into a laboratory for the testing of the black heart.

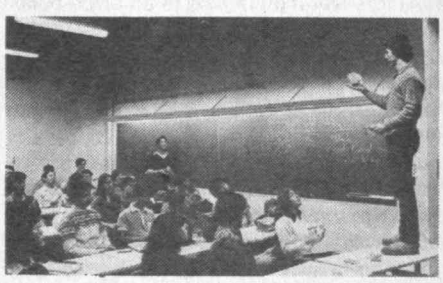
The moment came: on December 1 a bus driver chose the wrong black person to ask to move to the back of the bus. He asked Rosa Parks — fastidious, soft spoken, who wore her hair in a neat bun. She was sitting a little too close to the front. Had he known, he would have let her sit. But he asked Rosa Parks to move.

And she said softly, "not today." Suppose she has screamed profanity, or pulled out a knife. It would not have been effective. But she didn't.

Dr. King was in town to be an intellectual preacher, but he found himself organizing a bus strike. Dr. Proctor recalled spending a week with Dr. King, riding in his car while state troopers followed constantly, one car a foot behind the other.

Young black people were not asking to leave this society but to have a bigger stake in it. Their dissatisfaction was not with America; they were most American to ask America to live up to her charter and her constitution.

Blacks today need many leaders, not one messiah. Hundreds of thousands of teachers must learn how to be comfortable with black children. Hundreds of thousands of black children must learn algebra. We must develop diffuse leaders, who can speak clearly and plainly.—*M.L.*



Reusing Cities: Pro and Con

All of the new population growth in America is in suburban and non-metropolitan areas, where smaller communities offer fewer services and fewer jobs. What does this have to say about urban areas? asks Gary Hack, professor of urban studies and planning.

The shift of power from Eastern cities to the sun belt and from urban to suburban leads people to question the desirability of preserving older cities. The argument, he says: keeping cities that outlived their economic purpose, propping up people who should relocate, is misplaced effort. Social problems will be alleviated by investment in new things, not rehabilitation of old ones. If industries want to migrate to rapidly growing areas, we should make it easy for them to move; and if new housing is needed, let's build in surburbia, where people are attracted.

Professor Hack disagrees.

He is distressed by what he calls a terribly wasteful system — one throws away a city way before it is expended, he says. Through our tax system and related policies we've encouraged people to discard things and begin anew Americans value independence, but in most other societies it's thought a virtue to do things collectively. The American surburban household becomes attractive because it is more independent.

New Inefficient Land

Vast areas in the inner city could accommodate housing says Professor Hack, and the infrastructure is in place: roads, sewers, services, libraries. But development is *not* occurring in those areas, while people continue to migrate to new land where nothing is in place. This would be understandable if the new locations were more efficient than those they were replacing, but they are not, says Professor Hack. Houston, for example, has no way to use public transit, no storm drainage, no conceivable way of meeting its water supply needs over the next quarter-century. (Water tables are going down by three inches or so a year.)

Yet Houston is a prototype of the new kind of city. It has grown 400 percent in the last 30 years; 1,500 new households are born each week; 2,500 new autos are sold each week. There is minimal government interference in building, and no zoning, creating a remarkable collage in the city: a high-rise next to a private house next to a restaurant next to a warehouse next to an office building.

No zoning also encourages rapid and erratic change. A developer can buy an area, tear down what is there and replace it with whatever he wants. It's frightening, and people respond to such chaos and uncertainty. If you're fearful that you will suddenly find yourself with a warehouse next door, build a wall. That impedes contact with people. And to make it worse, there is no transit; if you have no car, you are excluded. You can walk a long way without seeing another person walking.

This distance between people results in another effect: stereotyping, says Professor Hack. With people so isolated from each other, more and more information is acquired by electronic means than by personal contact. Electronic technology gives the illusion that an enormously segregated population can communicate. Cable TV allows people to vote and interract, to debate vicariously on public issues. In theory, more people participate, explains Professor Hack, but it is an arms-length experience. The viewer never sees anyone and never has to confront real people. — *M.L.*

From Body Builder to Provider: How Masculine Stereotypes Evolve

From the "strenuous life" complete with body building and intense participation in sports to "the good provider," masculine roles in America have evolved from colonial times to the present. Dr. Elizabeth Pleck, a visiting research fellow at the Wellesley College Center for Research for Women, sketched prominent themes:

After the Civil War, the ideal man led a strenuous life. He was supposed to be an outdoor person, shaped by the military ethic. Domestic and foreign warfare, from the Civil War through World War I, had great influence. The military spirit was portrayed by a great bonding of men around the campfire. This idealized image created a search for the peacetime equivalent.

Organized athletics enjoyed increasing popularity. Nowhere, it seemed, could men be as close together as on the football field. It was a way to build character, masculine bodies, and companionship. Clubs such as the Boy Scouts were designed to make boys into men. They are all paramilitary organizations, with routines, drilling, uniforms, and emphasis on marshall spirit, or what was called "muscular spirit."

After World War II, other themes gained importance. The sense of buddies hanging out together in the saloon or barber shop in the late 1870s declined and was replaced with an interest in the relationship of men to women. By the end of World War I and extending into the 1960s, the ideal man was thought to be the good provider. Concern centered on this ability, especially in the depression; most families were supported by the man's income alone. Desertion and nonsupport became a civil matter; the state was interested in preserving the family.

The effectiveness of the provider was now measured by consumption items — a better toaster, a bigger house in the suburbs. So in the scramble for material rewards, work demands increased and competition interfered with male bonding. The retreat shifted from the saloon to the home, where one women understood and nurtured the beleaguered worker.

And what of the future? The rise of employment among married women, said Dr. Pleck, is a prominent social change. It's now normal for an American family to have two earners. And people are challenging the idea that there is any one acceptable standard. One must tread lightly today if tempted to tell people what they are supposed to be and how they are supposed to act, said Dr. Pleck. — *M. L.*

Among the great variety of activities during IAP: opposite page, Nancy Clark demonstrates rug braiding; this page, bottom: instrument pilot ground school, top: Origami, Japanese art of paper folding. (Photos: Mark Sloan, '81, and Calvin Campbell)

From Alumni with Wisdom: Set Your Objective, Then Go For It

"Do you think your army experience as an officer was valuable as training for management?"

"Yes, I had 40 guys who didn't want to be where they were, weren't very well trained; and we had to do something while they were shooting at us. It was a good management experience."

"Not that different from industry," said a voice from the audience.

Advice on careers was offered to IAP participants by the Trailblazing seminar, in which alumni brought their advice on life and careers to undergraduates. Some bits of counsel from various participants:

Make up your mind way in advance, set an objective, and go after it . . .

A good manager tries to understand what the overall plan for organization is, where you want to take it, and why.

See if you have the ability to get there, develop a plan, communicate it clearly, get your bases covered, and get talent to do the job . . .

Do what you enjoy; ultimately your original training doesn't matter. Look for opportunities and choose where your interest is . . .

The engineering approach to life is an excellent background for business.

M.I.T. College Bowl: Where? What? When?

Would you like to test your knowledge in the M.I.T. College Bowl? Then see if you can answer these questions:

1. The name of the horse who won the Triple Crown in 1948 is . . .
2. Which seventeenth-century North American princess was known in England as Mrs. Rebecca Rolfe?
3. Which two Caribbean nations share the island of Hispaniola?
4. Name the French military hero who won distinction during World War I in the Battles of the Marne, Ypres and the Somme, was appointed commander-in-chief of the French armies in 1917, and in 1918 was selected to command all French, British, and American forces.
5. Name the Armenian-American author of the novel *The Human Comedy* and the Pulitzer-Prize-winning play *The Time of Your Life*.
6. Name the New England state whose motto is "Hope."
7. Name the only two movies in the history of the Academy Awards that have swept the Oscars for Best Picture, Best Actor, and Best Actress.
8. Name the title and author of the novel from which the following last sentence is taken: "The offing was barred by a black bank of clouds, and the tranquil waterway leading to the uttermost ends of the earth flowed somber under an overcast sky — seemed to lead to the heart of an immense darkness."
9. Name the body of water under the control of Turkey which connects the Bosporus and the Dardanelles.
10. Name the father of the early Christian Church who argued vehemently against the Pelagian Heresy and is best known for a theological treatise, *The City of God,* and for his autobiography, *The Confessions*.
11. Name the first four people to have held the office of president of the Massachusetts Institute of Technology.
12. Two English Parliaments were summoned in 1640. List the temporal nicknames by which they are known.

It takes almost six months of planning to provide one evening of College Bowl competition. Work began last summer when the coordinator of the College Bowl, Lisa Cornelisse, assistant science librarian, reserved the moderator, Richard Reid, who is the son of the founder of College Bowl.

Thirty-seven teams took the preliminary exam this year. Four teams became eligible to compete, and the "Frozen Storage" team won: Dave Lebling, Tim Anderson and Stuart Galley, all staff members in the Laboratory for Computer Science, and Brian Berkowitz, a graduate student in electrical engineering and computer science — *M.L.*

How Safe Is Safe Enough?

When it comes to designing and flying a commercial airliner, where does safety fit in? Everywhere, said Professor James W. Mar,'41, to a full seminar room during IAP.

Commercial aircraft are kept flying safely because of good design, good practice, and good communciations, says Professor Mar, head of the Department of Aeronautics and Astronautics. It took failures in all three to cause the crash of American Airlines' DC-10 leaving Chicago on May 25, 1979.

☐ *Design:* Even with an engine missing, the pilot of flight 191 could probably have averted a crash had his controls and instrumentation survived. On other wide-body jets the hydraulic lines to wing control surfaces are behind the engine; Boeing deliberately put them there after an encounter with a bird during testing of the 707, and Lockheed, whose L-1011 was a late entry in the wide-body sweepstakes, simply copied the 707. The pylon of the DC-10, where the crack occurred, is not at fault. It's "well designed," says Professor Mar.

☐ *Practice:* McDonnell-Douglas' manual specifies how to change DC-10 engines in order to avoid too much stress on the pylons. American Airlines maintenance people did it differently, and by their ineptness during what was normally a safe (but not ideal) procedure they caused a crack in the rear bulkhead which gradually grew to failure under flight loads.

☐ *Communications:* Continental Airlines' way of changing DC-10 engines was the same as American's. But when Continental's maintenance people caused a similar crack they chanced to hear it, made repairs, and reported the episode to McDonnell Douglas. The same thing happened later to another Continental crew, and McDonnell heard about that, too. Someone at McDonnell Douglas could — and should — have asked some questions, says Professor Mar.

Clearly, said Professor Mar, the chance of so many different failures in so many different systems leading to the DC-10 crash is very low. But the question, How safe is safe enough? "has an infinite answer." As aerospace engineers, we have to keep on improving our record." — *J.M.*

What is a photograph? asks Gjon Mili, '27, in the text accompanying his photo of a juggler (opposite page). He answers: "a photograph is a brief collusion between foresight and chance. It need not invite reflection, so much as create a shock which alerts the viewer to the strangeness of the passage."

This page: Tanaquil Le Clercq, in La Valse, 1961.

Gjon Mili: Photos That Capture Time, Movement, and Humanity

"I feel a lot younger just being here," Gjon Mili, '27, told a large group assembled to see his photographs.

He showed slides from his just-published book *Photographs and Recollections* (see book review, this page) — an effort, he says, that was on his mind for two decades. "I was told that I should be proud; that is hard work. I am content indeed that I did not fail," he said.

He reminisced:

"Doc Edgerton and I were at M.I.T. at the same time. We would sort of bow, walking by each other in the hall. Then in 1937 came a crucial moment. Dr. Edgerton gave a lecture on a new fangled high-speed flash.

Afterwards he invited me to talk with him. I said, 'I'm with Westinghouse; but if you give me ten times the light, I'll quit and work with you.' He did, and I did. It was wonderful to work with Doc on a large breakthrough in photography.

"After 10 years of using strobes, I thought I should broaden my scope and began taking photos without a strobe. I learned the joys of humanism."

His photos of this time are studies in movement. Everything that moves has to stop, he says. A dancer rising, pauses before coming down. Mr. Mili catches that pause, with a snapshot taken in a theater without a strobe light. "People say how did you do it? And I say I didn't do it, I caught the moment.

"Whatever is not quite what it should be in words, it is so in photography." he adds.

He explained his photo of Picasso drawing with light. "He would laugh at you — he was not serious. So I invented an idea; to draw with light, and he took to it instantly."

If there is no accident, there is no interest in the photograph. "One needs a sense that it's not all studied," he said.

Mili's photos of Watergate are exceptional. He decided to take a photo of John Dean at the moment of oath, he explained. "I decided to shoot the spectacle — the photographers all lined up, shoulder to shoulder. I practiced for two weeks to shoot, without a flash, holding the camera without a tremor. I knew I'd have two chances. I was brave, he said, and took a chance." And the result should be the opening photograph of the history of Watergate. — *M.L.*

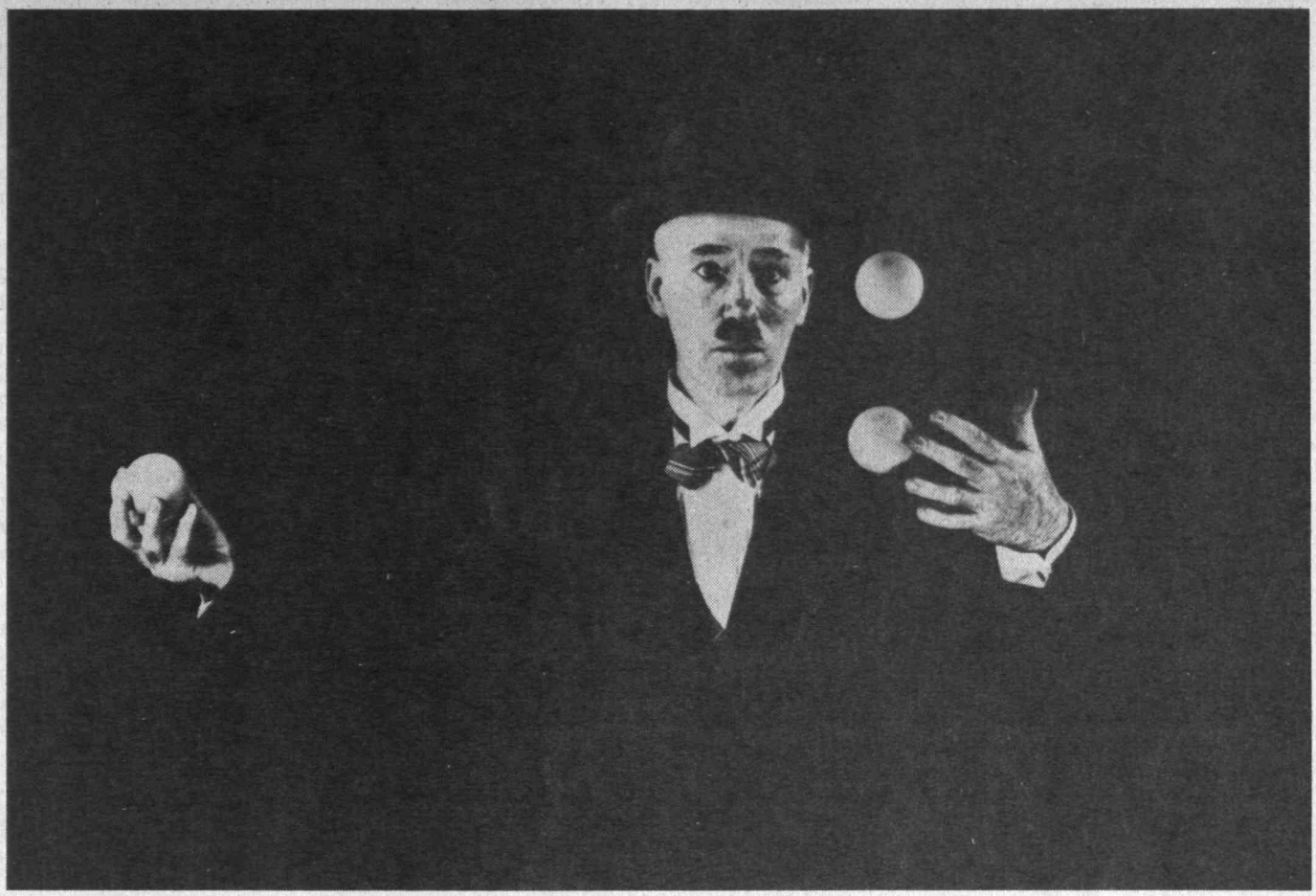
How Gjon Mili Has Devoted His Life to "Brief Collusions Between Foresight and Chance"

Gjon Mili: *Photographs and Recollections*
Boston: New York Graphic Society, 1980, $40.00

Reviewed by James R. Killian, Jr., '26

In 1937 both Gjon Mili and Harold E. Edgerton participated in a symposium at M.I.T. on lighting in photography. Mili, a native of Albania, had graduated in electrical engineering from the Institute in 1927 and had gone to Westinghouse, where, after a period as trainee, he moved into lighting research. It was at this 1937 symposium that he was introduced to the strobe lights that ultimately were to project him into a new career — that of photo-journalism.

With the electronic flashlights made available to him by Edgerton, Kenneth Germeshausen, and Herbert E. Grier, he was away and running as a strobe photographer. He shot a group of stop-action photographs that were enthusiastically accepted by the then-new magazine *Life*. Edgerton himself had already been taking stroboscopic photographs which provided for the first



time sharp views of milk drops, bullets, and fast-moving animals. In these beginning days of strobe photography, he made available to me a sequence of photographs for publication in the *Technology Review*.

Mili quickly achieved distinction as the pioneer professional strobe photographer, doing eye-opening movement-dissecting photographs, many taken on assignment for *Life*, of athletes, celebrated dancers, actors, musicians, and other performers in action.

Along with Edgerton, he ushered in a revolution in photography, and he helped greatly in building *Life*'s reputation as a premier magazine of this medium.

Now, in *Photographs and Recollections*, elegantly printed, Mili presents his own selection from the memorable photographs he has made since his first strobe picture in 1937. They illustrate not only his mastery of electronic flash techniques but his versatile command of non strobe photography. He learned the dramatic uses of back-lighted photography and thus gave many of his fast-moving figures an etherealizing, glowing profile of light. The photograph of dancers Charles Wiedman, Jose Limon, and Lee Sherman, "Unquiet Spirits Cavorting in Space," is but one example of what was to become his hallmark. He also brought back-lighting into striking use in his multiple-exposure photographs, such as his inevitable photographic version of "Nude Descending Staircase."

In a statement about Mili for an exhibit of his photographs in Paris, the late Jean-Paul Sartre noted that "This Mili is a man-trap. He is full of sleight-of-hand tricks that put you off guard. He is not satisifed merely to catch celebrities in his camera; he makes every picture a test, a trial. If he makes you a part of his collection, he will not only pin you, all alive and struggling, to his specimen board; but, beyond that, he will have observed you, he will know you through and through."

Of such character-revealing biograpical photographs I found of exceptional interest Mili's sequences of cellist Pablo Casals and playwright Sean O'Casey. Mili's relationship with Casals extended over two decades, and he shows the cellist during his self-exile in Prades, France, and then in his closing years in San Juan, Puerto Rico. Since I have had the privilege of knowing Rudolf Serkin, I found especially charged with emotion a photograph of Casals and Serkin embracing after Casals had been moved to tears by Serkin's "beautiful, beautiful" playing. Mili's sequence on O'Casey was photographed in 1953 and proved to be a "warm, joyful ritual" for both. As he does with Casals, Mili supplements his pictorial interpretations with informative, perceptive texts. In fact, throughout the album there are sensitive prose passages which provide an extra dimension to the character-revealing portraits.

In the text accompanying the photograph of a juggler, Mili asks "What is a photograph?" and he answers by saying that it "is a brief collusion between foresight and chance. It need not invite reflection so much as create a shock which alerts the viewer to the strangeness of the passage."

In addition to his many pictorial interpretations of famous men and women are Mili's fresh visions of majestic buildings, of Roman ruins, and of classical, Rennaissance and contemporary sculpture.

Concluding the book is an epilogue devoted to a visit he made back to Bucharest after 48 years in America and a touching tribute to his mother, to whom Mili lovingly dedicates his book.

But perhaps the best of all the portraits in the book is Mili's nonpictorial expression of himself unconsciously displayed by this great collection of portraits and recollections. Clearly he is a man humanistic in feeling, sensitive in art and generous in spirit.

We at M.I.T. will always cherish our own legacy of this great talent, including the collection of M.I.T. scenes which Mili photographed and prepared for publication years ago as his own tribute to his alma mater.

James R. Killian, Jr., was editor of Technology Review *when the first stroboscopic pictures by Professor Harold E. Edgerton graced its pages, and they collaborated in a volume which chronicles this development of high-speed photography:* Moments of Vision: *the Stroboscopic Revolution in Photography.*

Under the Domes

Tuition Goes to $7,400 — Enough "To Make You Blink"

Just before the Executive Committee of the Corporation met last month to make the final decision, President Paul E. Gray, '54, told *The Tech* that the tuition increase planned for 1981-82 was "another whopper. . . . It will make you blink," he said.

He was right: tuition for 1981-82 will be $7,400, up $1,200 from this year's $6,200. That figure, applicable to both undergraduate and graduate students, includes a health fee; room and board charges for 1981-82 have not yet been set.

Three factors were behind the increase, which works out to 19.4 percent:

☐ High rates of inflation affecting everything M.I.T. buys — but especially fuel and energy.

☐ The failure of other sources of revenue — investment income, unrestricted gifts and grants, and public and private student aid funds — to match the rate of inflation.

☐ The need for higher faculty salaries, especially for assistant professors where M.I.T.'s starting levels have fallen behind those of other universities and far behind those of industry.

More than half of all undergraduates at the Institute benefit from student aid funds — loans and scholarships — and Dr. Gray said M.I.T. is "determined to uphold the tradition that talented students with the capacity to do M.I.T.-level work will not be denied an M.I.T. education because of lack of money." With other sources inadequate, $1.5 million from M.I.T.'s operating income has been required for student aid during the current academic year. Next year the requirement will be $2.7 million, Dr. Gray said.

(Two weeks before the M.I.T. announcement, Harvard raised its tuition from $6,000 to $6,930, a 15.5 percent change. Professor Henry Rosovsky, dean of the Faculty of Arts and Sciences, cited "the general inflation rate and spiraling energy cost increases of 25 percent [in 1980].")

Tuition Rise Creates Spontaneous Annual Tuition Riot

"$7400? Too damn much!" Chanting loudly, but with smiles glinting in the bright sun, several hundred undergraduates joined the "spontaneous" annual tuition riot on February 13 next to Calder's Great Sail.

"Two, four, six, eight, we can't afford to graduate." The 60s echo was only a faint pulse, faded and nearly forgotten.

They tried to whip each other up. "Grumble, grumble . . . anger, anger . . . incite, incite," they repeated. Hardly a shred of tangible anger tainted the air. "What's the matter? We've lost the art of demonstration," came a plaintive voice.

"Let's go to President Gray's office," and the crowd and campus police converged on Building three, where about 200 jacket- and jeans-clad students settled on the floor, with Constantine Simonides, Vice-President, Francis Low, Provost, and Robert Alberty, dean of the School of Science, moving into the crowd to answer questions. Complaints surfaced first:

"The attitude the Corporation has is that there are always more students willing to pay."

"Why not look for more research money — raising tuition is the easy way out. See, *we're* customers too." (Clapping)

"The president's inauguration took up the entire tuition of 30 students for one year."

"Why not sell *Transparent Horizons*?" [the Louise Nevelson sculpture outside Building 66]

Campus police radio static provided background noise, mingling with band music filtering down the hall from Building 7 lobby.

Soon the interchange began to sound like a Corporation meeting on how to best combat pressing financial problems.

"Why is tuition going up faster than inflation?"

Dean Alberty's response: The cost of education is born by several sources: gifts and income from endowment and research are going up fast enough to foot the rest of the bill. Costs (faculty salaries, heat, light, oil) are rising, too. Something has to go up faster to keep up.

Would you want us to close buildings? Fire faculty? To reduce the tuition from $7400 to $7300, we must find $1 million in budget cuts.

After an hour of questions, suggestions, and answers, students dispersed. Finally only a lone campus patrolman lingered in the empty hall, his radio's static jostling the quiet.— *M.L.*

News from AMITA: Alumnae Springing into Spring

Chris Jansen, '63, and Lita Nelson, '64, have outdone themselves once again. For the sixth year a row they have presented a series of seminars during IAP, "Getting the Job That You Want in Industry: A Women's Guerilla Guide to the Pin-Striped World." This seminar series, sponsored by the Association of M.I.T. Alumnae (AMITA) attracted approximately 20 people this year.

As a follow-up to the issue of women and work, AMITA will be presenting a one-day conference "Getting On After Getting In" at M.I.T. on April 11, oriented towards women with work experience and focused on learning how to move ahead. Those who have paid dues to AMITA for this year should have received a mailing about the program. Others wishing information may contact Dr. Susan Kannenberg, 279 Winter Street, Weston, MA 02193.

Also coming up in the spring will be an expanded high school and junior high school visiting program, aimed at trying to encourage young women to keep options open for careers that require a technical background. Members of AMITA, joined by M.I.T. faculty, staff, and educational counselors, will visit high schools, particularly in urban areas of Boston, and they will be joining women in M.I.T.'s student chapter of the Society for Women Engineers to visit junior high schools.

Another exciting project underway is a videotape on M.I.T. alumnae in engineering careers. Emily Weidman, coordinator for women students' interests in the Dean's Office, is working with students and staff to produce a videotape. They will interview a number of alumnae at different stages in their career development (graduates of the classes 1978-79, 1972-74, and 1965-68), talking about what engineers actually do, what choices they have made in their careers, and how the women balance their personal and professional lives. Target date for completion of the tape is June 1981. It should prove to be quite interesting.

As a personal note, I would like to add that I am very excited about my new position as director of the Educational Council. I am particularly interested in seeing women, as well as minorities, better represented as members of the council. Educational counselors play a vital role in providing information to high school students about opportunties at M.I.T. I would very much like to hear from any alumna who is interested in being involved in this activity.

If you have any news to run in a future AMITA column, please write to me at M.I.T., Room 10-186, — *Bonny Kellermann, '72.*

Donald W. Douglas, 1893-1981 Pioneer in Aircraft Design

Donald W. Douglas, '14, who founded an aircraft empire with a $600 investment in 1920 seven years after he came to M.I.T. to indulge his interest in aircraft, died in Palm Springs, Calif., on February 1. He was 88.

Mr. Douglas transferred to M.I.T. from the U.S. Naval Academy. Following graduation, he remained at the Institute for one year as an assistant to Professor Jerome C. Hunsaker, '12, and together they hosted the formal opening of a new aerodynamic laboratory — the first of its kind in the nation — on December 15, 1914. By 1916 Mr. Douglas was chief engineer for the Glenn L. Martin Co., and by the 1930s his fledgling company had launched the DC-1 and then the immensely successful DC-3, of which more than 11,000 were built.

Mr. Douglas was a term member of the M.I.T. Corporation from 1958 to 1963, and he served for many years on the Corporation's visiting committee in aeronautics and aeronautical engineering. Howard W. Johnson, chairman of the Corporation, describes Mr. Douglas as "one of our most distinguished alumni in the field of aeronautics and astronautics" — a name "synonymous with the development of aviation on a global scale."

05

In July 1980 I received a letter from **Bill Spalding** which I intended to send to the *Review*. But the fact is I had so many irons in the fire I could not put my mind on apologizing for inaction as acting class secretary. I suggest that any '05 survivors write to Bill at 404 New Hampshire Ave., Norfolk, VA 23508. In July Bill wrote: "This is the day I have to bake bread." He goes on: "I'm still making out alone okay, tho' the old eyes don't see well. I'm becoming a landlord beginning August, for a few months. My youngest granddaughter, husband, and huge German Shepherd are moving in. My sister, at 93, is keeping house alone at her summer cottage in New Hampshire, and two brothers, 91 and 86, are active about their farms. So I think this family is doing well and very lucky."

I wish I knew how many of us there are left in 1905 to read Bill's and my contributions to '05 news. A year ago the *Review* sent me a list of half a dozen classmates, but there are probably fewer now. Bill reported in March 1980 **Roy Allen**'s death.

For myself I can report good health except for blindness and the fact the my feet and ankles are weak. — **Gilbert S. Tower**, Acting Secretary, 35 N. Main St., Cohasset, MA 02025

10

Cecil Blanchard sends the following note with his Alumni Fund contribution: "Not much activity of interest when one is 94, but I still mow the lawn, have a garden, walk about town, and read with the help of a magnifying glass. Also keep the house in repair and play with two great-grandchildren who live nearby. Nice to be active."

"**Florence Luscomb** dates her career as a crusader for equal rights for all human beings from the time she first heard Susan B. Anthony speak at the National American Woman Suffrage convention of 1892," says Victoria Morris in the March 1980 issue of the *Radcliffe Quarterly*. "She was only 5 years old then. Today, at 93, she is still carrying on that struggle." Ms. Morris goes on to highlight the life of Florence Luscomb first as a supporter and soapbox speaker for the Suffrage Amendment and later for black American rights and for organized labor. In 1909 she made 222 "courageous speeches" in 19 weeks. In a brochure honoring Florence Luscomb at a 1973 testimonial dinner sponsored by the Women's International League for Peace and Freedom, she is decribed as the "archetype of radical and humane committed woman, personifying both the women's movement and the progressive movement in this century." More recently, the *Boston Globe* featured her with her placards at the front of a picket line and, on another occasion, speaking at a 9-to-5 women office workers' rally in Boston's Government Center. She is currently living in Cambridge, Mass., in a communal apartment with people more than a half century her junior, and summers in Tamworth, N.H., in a cabin she built herself, concludes Ms. Morris.

We have a letter from Elizabeth Swanson, granddaughter of **French Philbrick Sargeant**, which tells of his passing on November 2, 1980. "He died peacefully, in his sleep, in Winter Park, Fla., his home for the past several years." After attending Exeter Academy, French went on to complete the naval architecture program at Tech. He spent his entire career (1912 to 1955) as a mechanical engineer in the government department of Worthington Pump Co. of Harrison, N.J. "This company, founded in 1840 and now part of McGraw-Edison, has been an important supplier of pumps and marine engines to U.S. Naval ships since the Civil War. It designed and built the pump used on the old *Monitor*. French was an expert in this field, and his knowledge and skill went into ships of both World Wars." French's major hobby was flower and vegetable gardening. He was a member of numerous clubs and in later years enjoyed traveling to Central America and the Caribbean region, for which he taught himself Spanish. French is survived by his wife Mary, two children (Frank and Ruth), three grandchildren, and two great-grandchildren. One great-grandchild is the daughter of John Niles, '68. — **Ralph W. Horne**, President and Secretary, 14 Winn Terrace, Malden MA 02148

13

In the last issue, I wrote that someone had predicted another "mild winter." Well, it hasn't come true. December was the coldest and windiest in years and the new year is starting out to be very cold.

We have some delightful notes in response to my recent mailing to the hardy members of 1913. **Dave Stern** writes: "No news — still 'recovering' from perforated aorta one and one-half years ago. Della and I are leading very quiet lives and now have our seventh great-grandchild. Our oldest great-grandchild is now a freshman at Georgia Tech."

It's always great to hear from **Charlotte Sage**. She's still a very active lady. She says: "My news is so completely domestic I hesitate to send it. Have just had my 13th great-grandchild. Still drive my "Scout" — perfect for old ladies as no one tries to push me off the road. Still spend summers in southern Vermont on a so-called tree farm. The village is being invaded by people from Connecticut due to a real estate developer from Hartford having discovered the area — ugh — I dislike developers. I came down for the inauguration at M.I.T. Saw **Walter Muther** there but have not heard from him since. Heard he had attended the Alumni Council like a noble officer and was congratulated on coming from the oldest class represented there. Now I am settled in for the winter in Brookline with a daughter, Polly Shakespeare, living with me. She works at the Massachusetts Audubon Society, so the house is filled with specimens of everything from flowers and twigs to beetles and worms. This is a handy location and serves as Grand Central Station — always someone coming or going or staying — it keeps me active and contented."

Cedric Burgher writes: "About news of myself and family: my children helped me celebrate my 91st birthday recently. I have four children and 14 grandchildren. We are expecting my first great-grandchild soon. I would like to attend our next reunion, but it is a long way from Texas to Boston. I really enjoy reading my *Technology Review*."

Joe Isenberg says: "Good Luck in '81." . . . **John B. MacNeill** writes: "Both Evelyn and I are in good health and enjoying grandchildren and their families as well as the intermediate generation. However, we cannot follow all the activities such as cold weather football games. Have given up Florida as a place for the winter with the thought that next time we go there we better stay. Right now (November 20, 1980) snow is on the golf course. Looking forward to family group action on Thanksgiving and Christmas. At 92 years, living is fun and the alternative not attractive. Best regards to all 1913 folks."

Mrs. **Gardner R. Alden** wrote in November that Gardner had celebrated his 89th birthday on October 13 and went into the hospital on the 14th in poor health. Then in December, we received word from Gardner's son-in-law, Phil Bliss, that Gardner died on December 15, 1980, at the Framington (Mass.) Union Hospital. Phil reports that Gardner graduated in chemical engineering and served as captain in the U.S. Army Quartermaster Corps in World War I. He was a research chemist with the Dennison Co. in Framingham for 30 years before his retirement as division manager in 1956. Gardner was a life member of the American Chemical Society, a member of the Independent Research Institute, and a member of the Boston Research Director's Club. He was also a member of the Converse Lodge in Malden, Mass. He married Alice Winifred Hodgdon and had three children, Phil's wife Ruth, her sister Priscilla Phipps of West Campton, N.H., and a son Gardner E. Alden of Southborough, Mass. Gardner also had 13 grandchildren and 13 great-grandchildren. After his wife's death in 1968, he married Bertha Ann Foss of Framingham, with whom he made his home in Framingham. Phil says, "We are an Institute family, with Gardner R., '13, Course X, Gardner E., '44, Course X-B, myself, '37, Course VI-C, and our son Jonathan Gardner, a graduate student in the M.I.T.-Harvard Division of Health, Science, and Technology. We try to carry on the tradition."

Our sympathy to a great "Institute family." — **Rosalind Capen**, Assistant Secretary and Treasurer, Granite Point Rd., Biddeford, ME 04005

14

The Alumni Fund reports for the fiscal year ending June 30, 1980, under the heading, "Other Alumni Giving," the sum of $573,706 credited to our class. From Mr. Johnson, of the Fund staff, we learn that this large sum came from the estate of **Oliver Earle Conklin**, a classmate who died in 1959. He came from Texas, was with us in our last three undergraduate years, received his bachelor's degree with us in Course VIII and his master's in the same course in 1917, after being an assistant in the Physics Department. Most of his career was as a physicist in a photo products department of E. I. DuPont Co. in Parlin, N.J. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

16 65th Reunion

Some of our classmates were fortunate to get away from New England and avoid the bitter cold in January. **Izzy Richmond** spent most of the winter in Arizona. **Nat Warshaw** escaped to Sarasota, Fla. . . . Grace and **Dan Comiskey** planned to join us for our November luncheon at the Endicott House, and we were concerned when they didn't come. Recently, Dan wrote that both of them had health problems which surfaced shortly before the luncheon, "but all is mended now after two months in the hospital and nursing homes." That's good news, Dan, and we'll look forward to seeing you and Grace at the Endicott House for our 65th Reunion.

Our 65th Reunion dates are June 3-5, 1981, and the location is the M.I.T. Endicott House in Dedham, Mass. Technology Day, Friday, June 5, is a traditional feature of Reunion Week, and this year's program will focus on the automobile. We hope to see all of you at our 65th.

While in Arizona recently **Ralph Fletcher** had the great pleasure of sharing lunch with **Joel Connolly**. Joel is enthusiastically taking **Nat Warshaw**'s advice and is walking 11-12 miles daily.

We regret to report the passing of our classmate, **Allen Giles**, on December 31, 1980. At many of our reunions, Allen played the piano for **Barney Gordon**'s singing. We'll miss Allen at our 65th, and we send our sincere sympathy to his lovely spouse, Mertie. Keep breathing, keep walking, and keep writing. And to this your secretary adds: keep eating, keep drinking — everything in moderation. — **Ralph A. Fletcher**, Acting Secretary, Groton Rd., W. Chelmsford, MA 01863

17

Inauguration Day gave us an opportunity to observe and inquire about last year's class gift to the Historical Collections — a pictorial history of M.I.T. displayed along the wall approaching the Margaret Compton Gallery. That day there was always somebody looking at it, and the Alumni Association reports that it is viewed contantly by students, visitors and alumni. Warren Seamans and his staff did an excellent job of putting the display together.

The Student Financial Aid office, through Fred Massie, gives us a report on our scholarship funds. From the Aldren Fund, income of $5,380 provides aid to three new Aldrin scholars, all sophomores in aeronautics and astronautics. They are Randolph S. Schweickart, of Washington, D.C., son of General "Rusty" Schweickart, '56, Richard A. Shapiro of Sharon, Mass., and Douglas S. Pennock of Atco, N.J. The freshman records and activities of these students are outstanding; they seem to be excellent selections.

The three Aldrin scholars benefiting from the fund last year graduated on schedule. Chien Huang, a San Francisco native, now works for GTE/Sylvania at Braintree, Mass. He took double S.B. degrees in aeronautics and astronautics and electrical engineering. Roberto Lopez (now Lopez-Aparicio) is doing graduate work. David Alexander returned to Oregon with plans unknown. They, like the present scholars, know that 1917 funds contributed to their aid.

Our 1917 Memorial Fund had earnings of $15,000 for scholarship asistance. At this time details of the distribution are not available.

You will recall that a fund was started at our 25th Reunion for student aid with preference for 1917 descendants. Although it ceased having contributions, it did amount to a little over $3,000. About 1964, the grandson of our **P. Y. Hu**, Chi Kuan Wu, entered M.I.T. knowing very limited English. He was awarded the entire 25th fund as a loan. In 1971 he received the S.B., and later the S.M., both in mechanical engineering. He now lives in Fairlawn, N.J., works at the GE Valley Forge Space Center, and has repayed over half the loan, a year ahead of schedule, after repaying his higher interest loans first. His is a remarkable record and most creditable.

Fred Massie, assistant director of student aid, expresses the thanks and appreciation of all concerned for the assistance these funds are and have been giving. Every '17er can have a sense of satisfaction that our leadership envisioned these funds, promoted the contributions, and accomplished the reality.

Howard Melvin writes from Santa Rosa, Calif.: "I have had a very quiet near-to-home year — golf, friends — and family visits — no long trips of interest to others — good health — and with the start of my 90th year a big birthday party given by our daughter. I have often said that Oakmont in the Valley of the Moon is as nice a spot for *Adult Year-round Living* as can be found anywhere in the world, and I have covered a lot of it. I am planning another trip to Washington State next June for my 70th Class Anniversary."

In December the **Stan Lanes** got off to Boca Raton, Fla., to stay until March. . . . **Harold Neumann**, due to the death fo his son Gordon, '52, is putting in limited time with Neumann Construction Co., which has just completed the 24-story Des Moines Marriot Hotel. . . . Colonel **Hubert Collins** of Fort Collins, Colo., has lost six inches in height due to arthritis. . . . **Alva Moody** from Denver reports that all is well including the 11-plus great-grandchildren.

Tom Hannah writes, "My wife passed away in September 1973. I finally got sick of talking to myself and joined the Old Guard of Rutherford, N.J. All we seem to do is to go to funerals. My daughter is the first woman to be elected mayor of Rutherford. She is finishing her second term now. My son, two years younger, on graduating from high school, made 28 missions as technical sergeant on a B-17 in the 8th Air Force in World War I but was killed in an automobile accident in 1949, leaving a wife and a one-year-old son. I have four grandsons, two great-grandsons, and two great-granddaughters." . . . With regret we report the death on October 14 of **Lewis P. Sanborn** of Saugus, Mass. he spent his entire business life with the Converse Rubber Co. retiring as controller. . . . Also with regret we report the death of **Ted Haviland** on January 7, 1981. — Secretaries pro tem: **Raymond S. Stevens**, 100 Memorial Dr., Cambridge, MA 02142; **Stanley C. Dunning**, 33 Christian Ave., Concord, N.H. 03301

18

You have been most gracious in returning good wishes to my season's greetings. I asked the question: Can rugged individualism and the social welfare state have a successful marriage? Your comments will be included in this and succeeding issues of the *Review*.

Greetings were returned from **George Sackett**, Elinor and **John Kilduff**, Winifred and **Sumner Wiley**, **Arthur Williams**, **Paul McAllister**, and Rhoda and **Charlie Tavener**. Marion and **Herb McNary** included a beautiful golden anniversary card, as did Gladys and **Len Levine**. Bealah and **Bill Foster** sent their diary from Washington.

A note from **Wilfred Holt**'s daughter states, "Daddy is about the same as last year — still at home. We have someone come in to take care of the house." . . . **Ted Braaten** writes, "Our 60th anniversary came on Rotary meeting day, so we celebrated it with fellow Rotarians and some invited guests. In late August we sailed to England on the *QE2* (Our third crossing on this beautiful ship). We always enjoy our visits to London and this time, quite by accident, we discovered that many of the theatres sell second-row seats to senior citizens at half price. We saw seven plays." . . . **Ed Little** sends greetings and comments on my question. "For my opinion on the matter, I am distinctly against a social welfare state. Rugged individualism has deteriorated to a most alarming degree." . . . **Eaton Clogher** adds his good wishes and says, "Living alone I manage to keep the house and grounds up, the house to my late wife's specifications and the grounds to my neighbors' satisfaction. I do very little driving now — actually I am in a car every day but just for errands about town. About your question — what makes you think I am knowledgeable in the science of humanitarianism? I'll give you a dime store's worth of an answer: eliminate *greed* and the world will roll along on ball bearings."

Walter Robertson writes, "Helen and I are in good physical shape and enjoy our growing family — most of them live within 30 miles of Canton, Mass. Our two daughters provided us with eight grandchildren, and now we have six great-grandchildren. Makes one feel ancient! Over the years the Robertson and **Jim Longley** families have maintained close contact. For several years, when we lived in New Jersey, we spent our vacations together at the Jersey shore. More recently we toured Norway, England, and Scotland together." . . . Ida and **Jack Kennard** send news: "Ida Mae and I are both well and play golf nearly every day, but no Florida this winter for the first time in many years. In answer to your question, an enthusiastic "YES." The masses who receive inadequate benefits are at least able to eat, while the rugged individualist has the comforting thought that his donations make this desideratum possible. So, both are moderately happy." . . . **Tom Knowland** says, "I do notice that our class is getting near the first page of the alumni reports. It won't be long before it will be on the first page, then the first entry on the first page. And the report will be signed, I'm just sure, and hope, Max Seltzer."

We note with sorrow the death of **James Flint** on October 9, 1980. On the same day **Fred Washburn** passed on. **John Braislin** died on November 2, 1980, as noted in the *Hartford Courant*. We have very late word from the Alumni Office of the passing of **George Malley** on July 31, 1978. Our sympathy goes to the families of these classmates.

There are more answers to my question to report next issue. — **Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard I. Levine**, Assistant Secretary, 510 Washington St., Brookline, MA 02146

19

In reading the Class of '19 notes in the January *Technology Review* I find that **Don Way** is reported as recovering from surgery. In fact the note applied to **Doc Flynn**, so I called Don to make apologies and found him in good health and planning a trip to Florida in February. While there he hopes to call on Mrs. **Gene Smoley**.

Classmates do not seem to spend much time at home, at least I hear the phones ring but get no answer. Not so with **Paul Blye** who answered with a strong voice to say he was well and enjoying visits with his children and gardening in season.

Not getting an answer on several calls to **Fish Gilbert**, we sent him as usual a Christmas card. I received a kind response from his daughter informing me of his death after a short illness on October 9 last year. Like his family, we shall miss

his ready humor.

Ev Doten has sent me some interesting material concerning **Robert Insley** who recently took residence in Whittier Towers where Ev has resided for the past eight years. This was the first contact of these two classmates during the past 60 years. Insley spent many years, following army service at McCook Field, with such companies as Continental Motors, Pratt and Whitney, and Lockheed. In the latter he was in charge of engineering. For the past several years he has done consulting work in New York City and Alexandria, Vir. All in all, an active career. My experience is that our classmates have all enjoyed rewarding careers equally worth telling. Remember to plan for our 65th Reunion! — **W. O. Langille**, Secretary, Box 144, Gladstone, NJ 07934

20

Your secretary's heart was gladdened by Christmas messages from Florence and **Lee Thomas**, Beth and **Ed Ryer**, Barbara and **Bill Dewey**, Denise and **K. B. White**, **Ming Pai**, **Frank Badger** and **Ned Murdough**. Margaret Brown, Vera Howe and Billie Gee were also kind enough to include me in their Christmas wishes. K. B. White sent a fine picture of himself and Denise, and I must say K. B. and the charming Denise don't look a day older than when I saw them in Paris a decade ago. Ming Pai informs me that he has moved from Washington, D.C., to live with his son, Dr. Coda Pai, at Latham, N.Y. . . . Frank Badger writes from Hollywood, Fla., that he was sorry to have missed the 60th. He rides a bicycle on the board walk to keep trim and tends his rose garden. From his wife Marge we learn that **Stan Reynolds** of New York City had a bad fall the landed him in the hospital but in now home and coming along. We send him our best wishes for a complete recovery.

A well-deserved tribute was paid to **George Wilson**, former Quincy High School principal, at the Quincy Kiwanis Club where he served as secretary for many years. "George Wilson is a remarkable man," said the master of ceremonies. George is a charter member of the Boston Mineral Club, a contributing member of the Braintree Art Club, has collected about 33,800 coins over the years on South Shore beaches using a metal detector, bowls weekly with a senior citizens group in Quincy, is involved in the Retired School Administrators Club, is active in the North Braintree Senior Citizens Club, and is a member of the Brookline and South Shore Birdwatchers Clubs. According to George, "My biggest thrill was attending the 60th Reunion of my class at M.I.T." Keep up the good work, George.

John B. Garrett died on October 6, 1980. A native of Roslindale, he graduated from South Carolina State College, went on to Amherst College and completed post-graduate studies with our class at M.I.T. He was appointed chief bacteriologist for the V.A. hospital in Tuskegee, Ala., and remained there until his retirement. He was a member and officer of the American Tennis Association for 40 years and a visiting aide for the Commission of Affairs of the Elderly. He leaves his wife, a son, two sisters, and two granddaughters.

I am indebted to Josh Crosby, the able assistant secretary of the Class of '21, for information of the death of **Lancy Snow** on December 27, 1980. Lancy lived in Venice, Fla., and before his retirement was senior building construction engineer of public works for the state of New York. He served with the aviation section of the Signal Corps, U.S. Army during World War I, and recently received a 60-year membership certificate with the American Legion. He was a member of the M.I.T. Club of Sarasota and a regular attendant at all their meetings. He was president of the 100 B's Club of North Port. He leaves his wife Irene, two daughters, ten grandchildren and four great-grandchildren. A popular member of our class, he will be sorely missed. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

21 60th Reunion

The Corporation Development Committee honored Assistant Secretary **Samuel E. Lunden** on November 16, 1980, when he was awarded the Marshall B. Dalton Award (*see January 1981, p. B3*). Sam, we of the Class of 1921 salute you.

Your secretary wants to take this opportunity to say thanks for the many Christmas cards received from class members and the bits of news contained there. Helga and **Jim Parsons** wrote that they were going to California for Christmas and were coming to the reunion. Marion (Mrs. **George**) **Chutter** is still driving her car. . . . Graciela and **Helier Rodriguez** planned to go to President Gray's inauguration but felt too tired after their trip to Spain. . . . **Leo Pelkus** wrote that his wife Vivian died last May. "We had a fine life together," he said. . . . Betty (Mrs. **Norman**) **Patton** reports that she's "still working, and in good health."

Dorothy (Mrs. **Joseph**) **Wenick** spent some time in Maine this past summer. Her son Martin who works for the State Department was promoted this year and was married in December. . . . The **Josh Crosbys**, the **Al Lloyds**, **Helen St. Laurent**, the **Robert Millers** and **Whitney Wetherell** all say they plan to come to our 60th Reunion. . . . Maxine and **Cac Clarke** are planning another Caribbean cruise this spring. . . . A long letter come from Celia (Mrs. **Frank**) **Huggins** that tells of her move to Fort Myers, Fla., and her activities in Shell Point Village, a retirement community. Celia planned to spend Thanksgiving with her son Tom and family in Charlotte, N.C., and Christmas with Sally and family in New Jersey.

Alumni Fund envelopes also brought news. **John G. Lee** attended an ASME meeting in San Francisco in August and delivered a paper on the Ford Trimotor. Said he, "On the way I stopped off at the Grand Canyon and had a flight over the canyon in a Ford Trimotor, over 50 years after I had been engaged in the design, testing and production of these airplanes. It seemed a good solid plane and more spacious than the many current airplanes." . . . **Arnold R. Davis** writes, "About three weeks prior to my 80th birthday, Mrs. Davis and I made a trip north to Connecticut, Massachusetts, New Hampshire, and Maine. We visited all of my 11 brothers and sisters. We enjoy reasonably good health."

Sadly we report two deaths this month. **A. Abba Orlinger** of Jenkintown, Penn., died on September 9, 1980. His career was spent in the practice of patent law. **Theodore P. Spitz** of Roslindale, Mass., died on October 20, 1980. He worked for the city of Boston. The sympathy of the class is extended to the families of these classmates.

Returns are now (January) coming in to the Reunion Committee and it looks as if a sizeable number are planning to come. Plan to join us! A number of classmates and wives have elected to stay in the dormitories. See you in June! — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Circle, Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015, (215) 746-7550

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We have welcome greeting cards from **Bill Elmer** in Andover, Mass., Vickie and **Ed Merrill** in the far west, and Irene and **Vernon Whitman** in Pomona, Calif. Vernon sends greetings to the class from their sunny and warm area made more exciting by nearby brush fires last year. . . . Madeline and **Parke Appel** write from Venice, Fla., of their wonderful winter and good times with the M.I.T. group in the area. Parke broke a few bones in his left foot while hurrying to get off an elevator which did not level properly. He will be okay by the time you read this news.

Dorothy and **Whit Ferguson** will be in Pompano Beach for two months and hope to see our nearby classmates during a golf or bridge game. It's really a shame to leave Buffalo during this beautiful open winter. . . . Charles Hieken '51 has forwarded an article on **Bill Elmer**'s being elected a fellow of the Illuminating Engineering Society of North America. Bill was cited for his teaching and publications in the art and science of reflector design, for his new contributions to that field, and for his application of such techniques to the development of innovative roadway lighting luminaires. Bill has had a long and illustrious career, beginning with Boston Edison and continuing with Westinghouse, where during World War II he was chief project engineer for a top-secret naval ordnance project, and with the Wheeler Reflector Co. of Boston. He resigned from Wheeler in 1958 to head his own consulting reflector design firm. Among the honors he has received is Hollywood's prestigious Oscar, awarded in 1962 for his Sylvania SunGun reflector design. In May 1976, he was named "New England Engineer of the Month" by the *New England Engineering Journal*. Bill developed the first mathematical solution to the problem of asymmetric reflector design using an ingenious spherical drafting board. His book, *The Optical Design of Reflectors*, is the first and only complete work on this basic and important subject. Congratulations Bill!

Royal A. Stone of Clearwater, Fla., writes about their last year's boat trip to Warren, R.I., including visits to commencement activities at St. Lawrence University in Canton, N.Y., for his 55th Reunion. Roy is now president of the Tampa Bay M.I.T. Club and received a special invitation to Paul Gray's inauguration in September. Roy continues to be busy as a caller for Common Cause, and he follows athletics with the Phillies. The Stones continue to live an active life in, around, and out of Clearwater. . . . An interesting article from the early 70s appeared in our M.I.T. files of radicals taking over M.I.T. and their confrontation and dialogue. **Abbott Johnson** and other classmates have helped foster changes bringing about today's solid and reliable feeling at and for the Institute. We are sorry to report our loss last fall of **Welrose Newhall**, Coraopolis, Penn., and **Donald B. Marsh** of Dennis, Mass.

We must report the enthusiasm of **Don Carpenter** for M.I.T. He is asking us all to get ready for 60th Reunion by starting contributions now. Please continue thinking of where and how our reunion should be held with suggestions to your secretary or president, Parke Appel, 404 Harbour House, Box 355, Venice, FL 33595. . . . Here's to you and an early spring ready to gambol on the greens. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horowitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, FL 33060

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John (Tex) Beretta was awarded a life membership in the Texas Society of Professional Engineers at the December 1980 meeting of the Bexar Chapter. In announcing the award, the president of the chapter said that "Jack" was the organizer and a charter member of the society in 1936 and is holder of membership certificate number 1. In addition to numerous other achievements, he was president of the National Society of Professional Engineers for 1941-42, Bexar Chapter Engineer of the Year in 1959, and a member of the State Board of Registration for Professional Engineers from 1955 to 1968. Tex writes that he is enjoying good health and happiness and that two more grandchildren have arrived in the last three years.

After 53 years of professional practice as an architect, **Bartlett Cocke** retired on March 1, 1980. . . . **Alfred Perlman**, currently a consultant to and formerly chairman and president of the Western Pacific Railroad, has been elected a director of the Commercial Bank of San Francisco. . . . **Miles Pennybacker** has been appointed to the Commission for the Elderly in Westport, Conn. . . . **Atherton Hastings** continues as a

consultant to the City of Florence, Ala., on solid waste problems, where by drilling landfill a sufficient flow of methane has been obtained to furnish the animal shelter with space and water heating. A pending project is to heat North Alabama with waste wood chips.

Vivian Skilton Frazier, wife of your secretary-treasurer, died on December 29, 1980, in Winchester Hospital, after a brief illness. She was born in Lawrence, Kan., daughter of Charles Sanford Skilton, noted composer. Services were in Trinity Church, Boston, where she had been president of the Women of Trinity Church.

Clarence Thayer died on August 15, 1980. Clarence prepared at Springfield College and studied courses in life sciences and public health at the Institute. He was first associated with the YMCA in this country and abroad and was later senior sanitary officer with the Florida State Health Department for some 20 years, retiring in 1962. He served as secretary, then president of the Miami, Fla., Alumni Club, member of the Educational Council, and a member of the Sons of the American Revolution. He served in the U.S. Navy in 1917. — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

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While an LPG tanker plows through ice-bound Boston (-4° F) harbor and oil barges follow the Coast Guard, your scribe doffs his mittens to loosen the Smith-Corona keys. **Blanchard Warren** writes from Lake Osewgo, Ore., "Nothing startling! Retired 15 years. Five children, two in Massachusetts. Thirteen grandchildren. Health is good! Mt. St. Helens volcano 40 miles away. Some ash." . . . **Robert Lindsay** writes, apparently from Rhode Island, "Consulting editor for acoustics, McGraw-Hill encyclopedia of Science and Technology."

Richard L. Holt passed away October 4, 1980, in Nyack, N.Y. Dick gained his S.B. in Course XV and spent his career as an executive with Orange and Rockland Utilities. He was an ardent civic participant, holding high positions as a trustee of Upper Nyack. Very active in the Boy Scouts, in 1971 he was awarded the Silver Beaver, one of scoutings highest leadership awards. He was also a 50-year charter member of the M.I.T. Lodge of Masons.

Ingram Lee died March 8, 1980, in Dallas, Tex. Ike was awarded a degree in naval architecture and marine engineering and was very active at the Institute, becoming managing editor of *The Tech*. Strangely, he entered the cotton textile business, then became an executive of a life insurance company. He was a member of several clubs and societies.

F. Berkeley Robins passed on December 14, 1980, in Jacksonville, Fla. He graduated with an S.B. in general engineering. He apparently joined the Atlantic Coast Line Railroad Co. organization and became assistant manager of the trailer train service.

William (Cam) Ross can not seem to break his chemical ties as he is still consulting for W. R. Grace and Co., Cambridge, Mass. . . . **Jack Walthall** stays pretty well in the South as he "took a nice Caribbean cruise this past summer; also a 3,000-mile trip to the Carolinas and Virginia this fall." . . . **Chris Conway** from Louisiana, "Keeping busy with gardening, church work, community concerts and service clubs. Have two grandchildren, a boy and a girl, now attending Rutgers University and two more (both girls) in high school."

Thank you, Nish, for your note recounting your pleasure seeing our New England foliage and Herb, Gordon, Phil, Frank, Russ and Ed. We all hope that Luisa's cataract removal was successful and that she now enjoys 20/20. . . . **Frank Shaw** does not do that well but manages to manipulate his wheelchair around the corridors. . . . **Don Moore**, 1981 acting mini co-chairman, was accidently floored by a door and is recuperating from a fractured lumbar vertebrae. . . . **Gordon Billard** sent a bulletin on his trip to West Germany last summer, concerning issues of great concern on the stability of the international monetary and banking systems.

Perry Marnard forwarded a clipping on the death of **Henry B. Zeiger** on December 10, 1980, in Larchmont N.Y. Henry gained his S.B. in electrical engineering but we have no further history on him. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, Co-secretary, 8 Pilgrim Rd., Waban, MA 02168

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Holiday greetings were received from a number of classmates and were much appreciated. A card from Lil and **Garvin Drew** informs us that Garvin is holding his own but is still in a nursing home and in a wheel chair most of the time. Lil visits him daily. . . . Lotte and **George Blonsky** wrote from San Jose, Calif., where they are now residing at 7250 Blue Hill Dr., zip 95129. George had his cataract operation and finally left New York early in November. Those of you who knew George will appreciate the following quote: "Luckily I have the best seeing eye dog in the world who not only wears glasses but also can drive a car and be pleasant about it. Incidentally, that seeing eye dog's name is Lotte and she is proudly navigating this old man through streets and all." George is very happy to be back in California.

Ben Oxnard's card noted that he had just returned from a Mississippi riverboat trip, one of the many trips sponsored by the M.I.T. Quarter Century Club. . . . **Franklin Fricker**'s card indicates that he keeps busy with several projects and notes that his children continue to press him to broaden the scope of his social activities. . . . Eleanor and **Fred Greer** are wintering as usual at Naples, Fla., but have moved to larger quarters so there will be more room for family members to visit. . . . Greeting cards also arrived from Adele and **Ed Kussmaul**, Hisako and **Kamey Kametani**, Elinor and **Sam Spiker**, and Ruby and **George Washington**. . . . **Jim Howard**'s greetings were tempered by the news of a telephone call from Margaret Blair informing him that **William R. Blair**, known to all his classmates as Rusty, had passed away on November 30, 1980, in Topsfield, Mass., folowing a coronary attack.

An earlier letter from class president **Ed Kussmaul** tells us that **Edward D. McLaughlin** has agreed to serve as our class agent replacing **Jim Howard** who has handled the job so well for a number of years. Ed enclosed a letter he had received from **Anthony Tsongas**. He lives in Lewiston, N.Y., but spends his summers at his cottage in Niagara Falls, Ontario, and travels to Mexico or Florida during the winter months. Anthony had hoped to make the 55th but family sickness prevented his coming. One of Massachusetts' two senators, Paul Tsongas is a nephew of Anthony's. Paul was brought up by Anthony's mother until he reached the age of 11. Anthony had belatedly learned of the death of our classmate **Leonidas C. Benos** in Douglaston, N.Y., on June 3, 1979.

A letter from Catherine Keck brought the sad news that **Daniel H. Keck, Sr.** had died on October 10, 1980, in Myrtle Beach, S.C., after a lengthy illness. Dan was personnel manager of the Kimberly Clark Corp., in Neenah, Wis., before retiring in 1966. He is survived by his wife, two sons, George D. Keck of Ohalla, Wash., and Daniel H. Keck, Jr., of Neenah, Wis., and six grandchildren.

I regret to report that **Roger P. Moore** died on October 25, 1980, at a Kennebunk, Maine, nursing home after a long illness. For many years Roger was the president of the D. T. Moore and Sons Insurance and Investments Co., Saco. A member of the First Parish Church, Saco, he had served as president and member of the board of directors for the Webber Hospital Association, served as secretary of the Biddeford and Saco Rotary Club for many years, and served as trustee and, at the time of his death, honorary trustee of the Saco-Biddeford Savings Bank. He is survived by a son, Robert S. of El Cajon, Calif., and two grandsons. — **F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26 55th Reunion

The nozzle of the jet blast turned down, and as a result the last week of December and the first of January have been at sub-zero temperatures here in the Northeast where we have been shivering, worrying about frozen pipes, and envying our more fortunate classmates in warmer climates. Meanwhile, plans are proceeding for our 55th Reunion. We have just received acceptances from **Edna Landau** and **Shantanu Kirloskar** to lead the entertainment program Friday evening, June 5, at the Chatham Bars Inn. Edna and Argo are about to leave for a stay in Hawaii until April 10 but have agreed to give us a view of "The Ghats of Benares" as background to an informal talk by Shantanu on the prevailing conditions in India.

Stark Draper visited the Kirloskars for about four days in India on his recent trip. Vikram Kirloskar, a grandson, is following tradition and hopes to graduate from M.I.T. in June, with Shantanu and his wife and daughter attending, after which they will join us at the reunion. . . . A letter from **Crockett Harrison** adds to the itineraries of our world travelers; the Harrisons have visited all 48 mainland states, Hawaii, Alaska, Australia, New Zealand, Tasmania, all the British Isles, Norway, Sweden, Denmark, Finland, Russia, Africa, the Far East, South America, Mexico, Central Europe, and others. That pretty well covers the globe and includes a few places Evelyn and I have missed but hope to see before time runs out. Crockett sold his company 12 years ago and has really enjoyed retirement, including particularly an extensive trip to the Balkans last summer followed by a celebration on August 30 of their 50th wedding anniversary attended by some 35 family members. Their 800-page family history now veing printed is another example of their family interest and solidarity, a focus somewhat missing in America today.

A note from **Alden Peterson** included some mislaid pictures of the 50th which we promptly placed in our album. He and Janet celebrated his 75th birthday in June 1978 with 65 of their relatives and Marvin Pickett present. They are planning to attend our 55th. An interesting aside to those of us semi-retired: he is on the 11th year of a one-year consultant's contract with one of our municipalities. . . . **George Makaroff** tells us he's "STILL HIKING" and, we hope, to the 55th. . . . From **George Breck**: "Am retiring from 20 years as president of the Eddy Family Association. Wife Ruth during the last 15 years headed up publishing of two books of about 550 pages each on Eddy descendant genealogy going back to two pilgrim brothers and several other pioneer Eddys and 'latecomers.' (Lots of work for us both and fine committee volunteers!) Among other things, I make special feeders for painted buntins which winter here in Fort Lauderdale (for local Audubon members.)" . . . From **Alonzo Ruff**: "Have retired from consulting firm and have started a new service on people versus machines — Expertise Assistance, Inc. — using service of other retired specific engineers. Also serve on SCORE, York, Penn."

From **Dave Powers**: "Doris felt that 20 years of professorial duties at Arizona State University was enough, so she turned in her resignation last spring and chose to take early retirement as professor emeritus. We are in the process of building a summer home (winterized for use during the winter ski season) north of Mancos, Colo., in the Rockies, on a ridge with a 359° view. We are looking forward to the 55th at Chatham Bars in the spring." When you arrive, Dave, the first question we will ask is "What caused the 1°

view obstruction?" . . . **Arthur Fuller** writes that he is looking forward to our 55th and had missed the recent brief omission of the class notes. . . . Notices have been received of the passing of four of our classmates: **Stuart W. John** on July 2 at St. Petersburg; **Richard W. Frost**, October 4; **Robert G. Maxwell**, September 21; and Dr. **Maurice J. Fish**, June 1, 1979, in Salisbury, England. Our deep regrets that they will no longer be with us. — **William Meehan**, Acting Secretary, 191 Dorset Rd., Waban, MA 02168

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Further reports from my California trip: Talked with **Alden G. (Al) Reed** in Los Altos who has been retired from the Nashua Co. now 12 years, is feeling well, and is active in community affairs. Recently he has taken up learning to play an electric organ. He remarked how he always used to look askance at all the pages of old time classes in the *Review* and now here comes '27 towards the front pages! . . . Nice visit with **Richard E. (Dick) Cheney** and wife Estelle in Santa Barbara who had just returned from another trip to England. They are collecting material for a book on the old Christians, "The Culdee Church of Scotland." Dick has a busy life with a wide variety of activities. After retiring as president of the Glass Packing Institute, he still has four principal clients with whom he is consultant to management, one of which is Coca-Cola of California, the world's largest bottler. The biggest problem today is to reduce the nitrous oxide emitting from the glass plants to try meet the environmental standards. It is said they produce one percent of the N_2O in Los Angeles and will have to spend hundreds of millions of dollars in revising the processing. Dick is consultant to the chancellor of the University of Santa Barbara, sponsoring a joint effort with the Chamber of Commerce and business and industry to train the college graduates in useful occupations. He also initiated and is now supervising a recycling of waste program entitled S.B. County Resource Recovery Commission. It is self-sustaining and is the second largest in California in percentage of reclaimed material — about 60 percent for newsprint plus bottles and cans. Dick has written a book entitled, *The Ten Commandments of Association Management.* Congratulations and full steam ahead, Dick!

Fred Willcutt and wife Gerry cruised the Greek Isles and Black Sea area in September-October 1979, and in July-August 1980 toured Glacier Park and the Canadian Rockies. Fred continues to swim a half-mile regularly to keep in shape, which he says is much easier than the hammer throw, (and no place to throw it). They are enjoying good health and looking forward to our 55th.

Dwight C. (Dike) Arnold died on November 29, 1980, in Wellesley. Past president of our class 1967-1972, chairman of our 50th and 55th Reunion Committee, and apparently our most healthy and active classmate, Dike was the epitome of the best M.I.T. alumnus. Following are excerpts from the tribute by Chairman Howard Johnson at his funeral service: "Just a week ago Dike looked wonderfully fit and tanned, just returned from Bermuda with Jean. Dike reflected on the difficulty of accepting the death of a close friend, and we agreed that time is not just something to measure but rather to experience and enjoy. . . . He was class representative on the Alumni Council since 1936 and was a faithful attendee of the monthly dinners. M.I.T. has lost a devoted son, leader in the Class of 1927, and distinguished former member of the M.I.T. governing body. It is difficult to do justice to Dike's record of service to the M.I.T. Corporation and to the Alumni Association. He became president of the Association (1955-56) and then served five succeeding years (1956-61) as an alumni term member of the Corporation. His assignments included chairman of the Greater Boston Area Mid-Century Campaign, Executive Committee (1947-49), Alumni Fund (1951-54), and vice-president (1952-54) of our Alumni Association. In 1977 he was awarded the Bronze Beaver, the highest award of the Association.

"Dike was director and officer of the Corporation which operates the Phi Beta Epsilon fraternity, and he encouraged the Institute to establish the Independent Residence Development Fund. (Dike was a benefactor to M.I.T. through the William Barton Rogers Fund.)"

Harold W. (Bud) Fisher, our president, writes: "Dike was a beloved member of the Class of 1927. He will be sorely missed by us. He had a way of making people feel comfortable in his presence. His classmates, like everyone he met, enjoyed him. He had a natural organizing ability which led him to take the initiative in planning reunions and other class activities. he was busy planning for our 55th Reunion to be held on Cape Cod. Those of us who knew him well understand the scope and significance of what he did to build an enduring bond of friendship and class spirit which will continue for many years."

Our deepest sympathy to the widows and families of these deceased classmates. — **Joseph C. Burley**, Secretary pro tem, 5 Hutchinson St., Milton, MA 02187

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First, our deep appreciation for the thoughtful greeting cards and notes received from so many of you at the year's end. We enjoyed every one of them. We were especially pleased to hear from a good number of our class widows. As with last year, our own greetings did not get launched until well after the holidays. This, at least, allowed us to answer most of the notes.

With advancing years more than a few of our classmates have found it desirable to change addresses. A cheerful note from Peg and **Bob Proctor** tells us that they have moved from Leominster, Mass., to Huntington, W.V., so as to be closer to their children's families. All of the many young members are doing well and Peg herself has taken a position in a new local library. As for Bob, he is looking forward to '83! . . . Marie and **George Chatfield** have moved from Lunenburg, Mass., to Rindge, N.H. Their new home is on the sandy shore of Lake Monomonac. Their list of grounds amenities reads like a resort ad and it is obvious that neither of them will ever be at a loss for something to do. It appears that Marie has lots of social activity. George goes to his newspaper office in Fitchburg (Mass.) several days a week (30-minute drive) and keeps up his amateur radio (ROAR) activities. . . . Marjorie and **Bill Bendz** have moved from California to Maine where they now enjoy a countrylike setting on a two-acre wooded lot. This is only about an hour's drive to Boothbay Harbor where they like to be in the summer.

We have a most refreshing letter from **Walter Hodder**. Walter was widowed about four years ago. Last year he married Blanche Arne, a family friend for many years. They bought a new house and started a "whole new and happy life." With many interests and activities, Walter says he feels better than he has in 15 or 20 years. . . . Gracia and **Tom Harvey** complain that last year passed much quicker than any other. For them the high point was a trip to South Africa. Besides the usual sightseeing, their visit included family reunions with Tom's kinfolk (of whom there are many) and a 915-mile ride on the famous luxury blue train from Capetown to Johannesburg. . . . Peggy and **George Mangurian** had a very enjoyable three-week vacation in England last summer. They exchanged houses with a family in Hereford. This gave them a comfortable place to live in and a base from which they could drive to many places of interest. The arrangement worked out so well they hope to do the same thing next year either in England or in France.

Alice and **Vic Decorte** write that they are well and enjoying life. In December they took a 25-day cruise on the *Royal Viking Star* from San Francisco to Hawaii, Tahiti and other stops on the way.

Christmas and New Years Day on the high seas! . . . Betty and **Dud Smith** had an eventful 1980. This included their 50th wedding anniversary, Dud's 75th birthday and a three-week tour of China. This was followed by a nine-day stopover in Honolulu. They were greatly impressed by the welcome they received in China.

It is with deep regret that we must report the deaths of three classmates. **Joseph L. Collins** died on November 7, 1980, after a long illness. Following graduation (Course XIV, electrochemical engineering) Joe went to work for Sprague Electric Co. in North Adams, Mass., where he progressed to director of research and engineering. In 1953 he went with Aerovox Corp. in New Bedford, Mass. Later he entered upon a successful consultant-agent career with Aerovox and other companies. News relative to Joe's passing was received from his wife Tay. **Alva H Pearsall** died on June 23, 1980, after a brief illness. Al graduated from Course IV-A, architectural engineering, and went into a busy life of varied activities, most of it in Rome, N.Y. He taught mathematics, had his own successful construction company and was prominent in many civic activities in that city. We had two friendly letters from wife Helen along with some of Al's biography. Al had three daughters, nine grandchildren and sex great-grandchildren. We have only a brief note to the effect that **Everett E. Potter** died in September 1978. Everett studied in Course VI-A, electrical engineering. Our records show that his professional career was with Bell Telephone Laboratories. To each of these classmates' families we extend our heartfelt sympathy. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Richard Wilson, '76, son of **John J. Wilson**, honorary chairman of the M.I.T. Corporation, won the 1980 Newport-Bermuda Race last summer in the 42-foot double-ended ketch, *Holder Danske*, owned by his father. Richard entered the race expecting to do well but not that well. The boat was designed primarily for cruising by the Danish designer, K. Aage Neilson. It was named for a Danish folk hero who, like King Arthur of England, will awake again when Denmark needs him.

John Happel of Hastings-on-Hudson, N.Y., writes, "My wife Dottie and I enjoyed being with you and meeting you and your wife at our 50th Reunion, first time since graduation. I haven't been to Boston since, but had planned to visit my daughter Ruth at Harvard. Dottie has been there several times. I have been busy as ever at Columbia and CRC this fall. LAst week I attended a meeting of AICHE in Chicago. While there, I had a chance to go to an M.I.T. cocktail party where I met some of the professors toasting the new chairman, Jim Wei, who is a friend of mine. Jerry McAfee, Sc.D. '40, chairman of the board of Gulf Oil, gave an interesting talk on energy." (Note: Your secretary has received a number of inquir-

ies concerning my operation last summer, which I appreciate. I am happy to say that all is well with me, healthwise, once again. And thank you.)

Richard Piez of San Mateo, Calif., writes, "My sister and I had a two-week visit in Florida last October, my first trip there, which we enjoyed immensely. We started from Tampa going south to Naples, to Key Biscayne, Del Ray Beach, Kennedy Space Center, and back to Tampa. Best of luck to you and the rest of the '29ers."

Malcolm H. Hubbard of Newton, Mass., writes to say that his and his wife Elizabeth's health have not been too good since their last trip to North Africa in early 1979. Both are improving gradually and expect to get out more than at present. After giving noteworthy service for more than a decade, "Mac" recently resigned as treasurer of our class due to his temporary health problem. . . . **William J. Degnen** of Westfield, N.J., writes, "After 13 years of retirement, at age 78 I'm enjoying the leisurely life very much. Now and then, I undertake a little consulting which I enjoy doing, particularly if it involves fluid catalytic processes. I had surgery last July for my gall bladder, but I am back in good shape and recommend it to anyone who is afflicted with such a problem. Thanks for the birthday greetings to you and any other '29ers who remembered me, particularly **John Rich** of Nashua, N.H."

Edward R. Godfrey, Jr., of Huntington, N.Y., sends a note that he and his wife have not run away from the cold weather as yet. They do take winter trips, mostly to the Caribbean and sometimes to Hawaii. "Age has dictated no more single handling of my boat (ketch)," he continues, "since my wife has 'beached' herself. Under the circumstances we decided to sell our boat after 13 wonderful cruising summers. Our 11th grandchild is due in February, and our 50th wedding anniversary comes in April." . . . **Thomas W. McCue** is continuing his business activities in various fields and continuing his educational courses at Boston University.

A letter written by Mrs. Ruth Oakman, sister of **George Burgess**, announces his death on October 17, 1980. She writes, "George had been hospitalized for a heart condition which rapidly deteriorated. In mid-September he was not receiving visitors." George served in the Quartermaster Corp. in Washington during World War II. After the war he moved from his hometown of Needham, Mass., to Cincinnati and was employed for many years by B. F. Shurtevant Co., an engineering firm. He moved to Hawaii in 1944 and became assistant to the president of the Hawaiian Pineapple Co. In 1956 he moved to San Francisco assuming the duties of president and chairman of the board of the Fiber Board Co. He leaves two sisters, both of Needham, Mass.

I received a note from Louise, wife of **Robert Sutherland** of Treasure Island, Fla., stating that her husband passed away on November 4, 1980. "He always enjoyed receiving the birthday cards from the class of 1929," she says. Alumni records also indicate that **Armistead Wharton** of St. Petersburg, Fla., died in July 1980. — **Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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Since our arrival in Green Valley in mid-October, we have had visits from two classmates who are living in Arizona. Several weeks ago, Betty and **Ed Kingsley** drove down from Mesa, which is in the Phoenix area, to spend a couple of days with us. From Ed we learned that **George Wadsworth**, our new class president, and his wife Lue have rented a place in Leisure World, near the Kingsleys for the month of January. This raised the interesting possibility of having a mid-winter class officers meeting in Arizona. However, it turns out that Louise and I will be in Portugal and Spain during the time that the Wadsworths are in Arizona. We had a visit from Margaret and **Ted Riehl**, who live less than an hour's drive from us. The Riehls are now Arizona residents and have a lovely home in the foothills of the Santa Catalina range north of the center of Tucson. They recently returned from a three-week cruise in the Aegean and Eastern Mediterranean and gave a glowing account of their travels. . . . Several weeks ago I had a chat on the telephone with **Ed Mears** who has retired to Wickenburg, Ariz., which, although in the same state, is quite a distance from Green Valley. As an incident of this telephone conversation, I learned that Ed's son Walter recently came to Arizona for a meeting of some 700 newspaper editors. It appears that Walter, who is vice-president and Washington bureau chief of the Associated Press, was a member of a panel that discussed the media coverage of the 1980 election campaigns. Also on the panel were Reagan's and Anderson's press secretaries. . . . **Helen Lustig Thornton** has retired fom the Brewster, N.Y., high school where she taught mathematics and is now keeping busy as a volunteer librarian. Since her last report to me, she has acquired twin granddaughters, Christine and Laura, now ten years old. The twins' mother, Lou Ellen, is a social worker.

As previously reported in the Notes, **Franklin Temple** retired from Foote Mineral Co. of Exton, Penn., a number of years ago. He and his wife are living in Devon, Penn., where he is associated with a savings and loan bank as outside representative at mortgage settlements. . . . We have a notice at hand that **Albert Deyarmond** died in Sonoro, Calif., on November 20, 1980. According to my records, he was born in Nova Scotia and retired in March 1971 after 13 years with the General Electric Center for Advanced Studies (TEMPO) in Santa Barbara where he led and participated in studies of weapons systems using advanced aircraft, guided missiles and space vehicles. Prior to his association with GE, he worked as an aeronautical engineer with the Kinner, Northrop, Ryan and Vultec aircraft companies. During World War II, he was a colonel in the Army Air Force where he won a bronze star and commendation ribbon for technical intelligence work in which he brought several tons of documents out of Germany and interviewed German scientists. After his retirement in 1971, he continued to do consulting work and was active as an elder and clerk of the session of the El Montecito Presbyterian Church. He is survived by his wife, Christine, a son Bruce, a daughter Susan and two grandchildren. — **Gordon K. Lister**, Secretary, 294 B Heritage Village, Southbury, CT 06488

31 50th Reunion

If any of you have not yet received any of our 50th Reunion Committee mailings, please drop me a line or write to **Dave Buchanan**, 9 Orchard Hill Rd., Peterborough, N.H. 03458. The latest word from Dave before publication: "Quite a few more answers have been received, and we now have 182 for the Vineyard and 208 for the Cambridge activities. We have information regarding the red coats and the final February mailing will carry order forms for the jackets and slacks.

A Christmas note from Yoshiko and **John Minami** regrets that he doesn't think they shall be able to make our 50th Reunion. . . . Bert and **Jack Lane** were in Ft. Lauderdale for a while before Christmas, but unfortunately we didn't have a chance to get together. Jack is still enjoying his affiliation with C.F.R. and getting together at meetings with his associates. Bert said that she isn't very active but gets to enjoy several trips with Jack. . . . A note from **Bill Stellrecht** in Stuttgart says, "The holidays are drawing nearer, and that is a good time for remembering old friends. You are probably quite busy in preparing the 50th Reunion. Unfortunately, I will not be able to attend. I miss your business trips to Germany including Stuttgart." . . . Louise and **John Swanton** are planning to attend the Florida M.I.T. Fiesta at Cypress Gardens in February. Helen and I are looking forward to seeing them at that time. . . . A Christmas letter from Ella and **Emile Grenier** tells about their trip to England — feeding the ducks in the winter and the racoons in the spring — and about Emile's efforts to have the Airbag-Passive Belt Mandate rescinded. They also plan to attend our 50th Reunion.

John Dodge says that his activities are chiefly concerned with revising textbooks that John and colleagues have on the high school market. They have just completed the fifth edition of *PSSC Physics*, the high school course that got its start at M.I.T. back in 1957. . . . **John Vasta** has retired from the U.S. Navy. . . . **Joseph P. McBrien** asks me to include in the Notes the recipients of the 1979 Harold E. Lobdell Awards. (Note: Joe, send me the information.) . . . Skeex Dean (**A. G. Dean**) writes, "I retired from the Budd Co. in 1969 and have been consulting for them regularly, and others occasionally, since then. Right now I am leaving for Australia, Japan, and Korea on licensee business." . . . **Ben Steverman** tells me that he sees **Sheldon Smith** and his wife, Harriet, regularly at the Cape Cod M.I.T. meetings. They are both well and happy, living in Falmouth where Shel enjoys his boating and loafing. Another Course XV man Ben sees at the meetings is **Everett Swift**, who now lives in West Falmouth after retiring from the Foxboro Co.

Looking forward to seeing you all at our 50th Reunion.— **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; Assistant Secretaries: **John R. Swanton**, 27 George St., Newton, MA 02158 and **Ben Steverman**, 3 Pawtucket Rd., Plymouth, MA 02360

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During the telethon I had the opportunity to talk with several of our classmates. **Kenneth B. Thompson** reports that he retired in 1972. He reads a lot and does volunteer work. He has no wife or family. We hope to see him at the 50th Reunion. . . . **E. Allen Newcomb** of Montclair, N.J., is recovering from a heart attack. . . . **Charles H. Pierce** retired in 1973. At present he is the treasurer of Roger Pierce Daycare Center, and he and his wife Betty have three boys and four grandchildren. . . . **Hollis W. Stokes** of Slidell, La., retired in 1974 and at present he is training for a pilot's license. He and his wife Mary have four children and seven grandchildren.

Edwin C. Beck of Muskegon, Mich., retired in 1975 and enjoys skiing. He works in his yard, on his Triumph 1961 PR3, and also does stained glass work. He and his wife Lerlain have two sons and five grandchildren — all boys. . . . Professor **Elmer Stotz** is engaged in some part-time projects since retiring in 1977. His hobbies are gardening and reading, and he and his wife Doris have five children and twelve grandchildren. They like to travel when possible. . . . **George Goodman** and his wife Nettie are active in their retail stores. He pursues his hobbies of being a Bosox Club booster and a golfer (handicap 23 or 24). . . . From the Alumni Fund comes a note from **Lawrence C. Littlefield** who served as executive officer of the Putnam County ABC Board of New York State Liquor Authority from 1969 to 1975, when he retired. The previous 35 years he was a safety engineer and underwriter mainly for Aetna Life and Casualty Co. He and his wife have been traveling widely for the last five years and help their three children and eight grandchildren with their problems when necessary . . . **Guy C. Lentini** writes that he and his wife are happily retired on Cape Cod.

So far this has been a cold winter. My wife Ruth is going to the Biscayne Bay for the month of March. I shall join her for the last two weeks, and then we'll take a leisurely ride by auto through the South and back to New England. All for now; keep writing. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

Christmas messages come first. The **Ken Smiths** of St. Pete have two children and two grandchil-

dren. They both claim top health. . . . Charalee and **Dick Fossett** are still hikers. Recently they were able to take a canal trip to the Antilles. . . . **Harry Summer** congratulates me for some honor or other and sends health wishes. . . . We have a card and a longish letter from **Art Hungerford**. . . . Betty and **Henry Kiley** send greetings and say that they are still coping. . . . Doris and **Len Julian** send us their usual Christmas greetings and a rather long message. . . . Mildred and **Berj Tashjian** send us a most unique card with the whole score of "Joy to the World." . . . **Westy Westaway** always sends us cheerful messages. Folks, I sure appreciate all these cards, and they do this old heart good. I love you all, for sure.

Every active member of our class should have received by now President Murphy's letter with the complete news of Roz and **Ellis Littmann**'s passing in so tragic a manner. Fred also suggested that we all, as individuals, contribute to the Ellis C. Littmann Scholarship Fund, founded by Ellis himself. All of us have not yet contributed, and financial reasons are not adequate. Any sum whatever will make this scholarship a little better. President Murphy has made it a 1933 fund, and I know that Ellis would have been very enthusiastic over the way it has turned out. Fellows, if you never have given to M.I.T., and many have not, now is the time to redeem yourselves. Do something for the man we all loved, who did so much for his (and *our*) beloved school.

We have 12 family letters, mostly family annual reports. I am forced to implore writers of family reports to instead send me a typed, postal card once a month. Class notes' space in the *Review* has been cut down to a minimum.

Bill Pleasant's idea of saving gas, time, and tempers: the construction of overpasses at busy intersections now served at street level by traffic lights. Bill proposes building two lanes over the cross traffic in metropolitan areas. Trucks would still have to use the lights, but they would be off to one side, so as not to impede through traffic.

We have a fine letter from Vice-President **Bill Harper**. He says, "Our class emerged in a period of no jobs, no money, and no relief or welfare. My question, 'Did that hurt us as a group?' " Heck no, far from it. Thanks, Bill. We have a little room for philosophy, but not too much.

Several Alumni Fund capsules (always encouraging): First time in 15 years I get a capsule from **Rein A. Wilson**, who announces that he is a retired internal revenue agent! Rein, how could you possibly wait so long? I have a list of those who have never written me, and it is too dang far long. Send some more about your family, and work methods. Anyway, thanks. . . . **Fozi Cahaly** writes that he is still president of Fay, Spofford, and Thorndike, Inc. No comment needed, sezzee. . . . **Philip S. Cook** writes that he has been retired ten years, does gardening, home and auto repairs, and some traveling to Florida and to the West Coast. . . . **Frank Gilmore**, a fine correspondent, writes that he is active in the Cape Cod M.I.T. Club and other Cape activities. He also still helps out at Cornell, where he taught for years. Further, he has a home in Arizona in the Santa Rita Mountains, south of Tucson. Leona and I studied that area with the idea of buying years ago but decided it was too far from anyplace. Aside from Ellis Littman, we have only one death to report this time — **Jim Vicary**. Jim was a Glee Clubber, and a very good friend, though I never did know what course he was in. We are writing Mrs. Vicary at once. That's it for this time around. — **Warren Henderson**, Fort Rock Farm, Box H, Exeter, NH 03833

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Once again news is scarce and restricted to Alumni Fund notes. **John F. Haines** is now living in Cape Coral, Fla. He has turned to a hobby that is close to model making — a subject close to my heart. He says, "Retired since 1977. Spending considerable time in building a series of small working steam engines illustrating the development from Fulton's *North River* (usually called the *Clarmont*) to compound engines, both paddle wheel and propellor. These have been displayed at several museums." They must have entailed a great deal of machine work, and I suspect John had to make patterns for many parts and then get castings made.

Bill Coleman is still in Florida. He writes, "Feeling the effect of inflation. Still in Florida — busy with Civic Association and United States Power Squadron Boating Course administration. Regards to all."

The last item comes from the West Coast. **David Tashjian** says, "Retired from Lockheed Missiles and Space Co., Sunnyside, Calif., in 1976. My wife, Georgian, and I have done quite a bit of travelling — mostly in England — and together we have published three books (all non-technical). We are shortly to move to The Villages, a retirement community in San Jose, where we hope to play enough golf to develop an 'idle ethic' — then off to England again." I don't play golf, but I'm all in favor of traveling, especially in England. We expect this April to pick up the trip that was interrupted last May when we had to come home early because of sickness in my family. That is, if we last through one of the coldest winters New England has suffered in years. — **Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20015

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Some excerpts from **Lester Brooks**' letter: "Although I would have preferred being a work monger, practicing my specialty of generating profits with new products and processes, I felt my desk being dragged out from under me like the *Fortune* cartoon of a few years ago, so I retired on June 30, 1980. For some time I've been eyeing the country in northwest Georgia. We finally picked a spot 75 miles from Atlanta and moved the last week in July. Now that we are here, I can report that it is beautiful. We have a seven-year-old house, the works — central air conditioning, 21 acres of pines, hardwoods and fields, a creek, a pond full of fish, and abundant wildlife — all for vastly less money than property in Fairchild County, Conn. With only five to eight homes per mile, I love the seclusion and quiet. Although we joined the lovely Cherokee Golf and Country Club eight miles away, I've played golf only four times. There are too many other things to do. Golfers and friends are invited to visit us at Knight Rd., Rockmart, Ga."

Ned Collins writes, "Congratulations for the original and unique method you devised (for the Class Golf) to enhance competition regardless of handicap and/or the golf course played on. What could possibly be more competitive than the fact that the two finalists were not only the Consolation Flight winners but that their winning margin was only four tenths of one stoke? After reading this, those of our classmates who now have the time to play golf (and sometimes poorly) will realize they can compete in the 1935 tournament and, I hope, will sign up for the 1981 tour. I spent an evening recently on the M.I.T. Alumni Fund telethon and spoke with some classmates who were as surprised as I was to learn that the average alumni contribution was quite low, even though others had subsidized us $1600 in four years (50% of tuition costs) when we were at Tech."

Bill Parker writes from Bella Vista, Ark., "**Otto Zwanzig** and his wife Alice were here for three days last spring. Otto was hot after a consulting job which he finally landed and has spent most of the summer and fall in Europe as a result. Alice gets to see him only on his trips back to New York to report to the company. However, he got home for the election, and we are planning to get together along with the **John Moorings**. It will be the first time we have been together for 40 years!"

While on the Alumni Fund telethon I talked with **Paul Herkart**. He and his wife Janice moved to the "country" in Belle Mead, N.J., twelve years ago and now live "in the middle of the woods." Paul raises African Violets which he gives to the local hospital to sell. They spend vacations in Vermont near Vergennes. on land they own. I also talked with **Frank Trifari**, a Course VI friend who retired over a year ago as vice-president of U.S. Philips Co. . . . **James Evers** retired in 1976. . . . **Frank Wilkens** also retired in 1976. He had been with RCA at Burlington for a number of years. He and Mercier recently celebrated their 40th wedding anniversary. Frank keeps busy around the house and does volunteer work. . . . **Arthur Linn** does ocasional consulting work. All five of his children are away from home and have produced 12 grandchildren. . . . **Leslie Fitzgibbon**, currently of Garden City, N.Y., is very active with tennis activities. Two years ago he was treasurer of the U.S. Tennis Association and is currently treasurer of the International Lawn Tennis Club of the U.S.A. He was going to Mexico in December for matches there and last August played in the Gordon Cup matches against Canada. He has been to Wimbledon numerous times and has played in senior events twice. He was captain of the U.S. Brittania Cup Team. His son is the national platform tennis champion. . . . **Ted Earl** is retired and spends his summers in Winter Harbor, Maine, and the rest of the year in Connecticut. . . . **Joe Simendinger** retired two years ago from Sikorsky.

I regret to inform you of the deaths of three more of our classmates. **Guy D. Johnson, Jr.** died in Lincroft, N.J., December 11, 1979; **Guy A. Cruse** died September 5, 1980, in New York City; and **Gerald C. Rich** died October 28, 1980, after a long illness, on the West Coast in San Jose. I am sending the sympathy of their classmates to their survivors. We also send our sympathy to **Chet Bond** whose wife died in Swampscott on December 5, 1980.

Bernie Nelson talked to some of us here in Boston, and because of the cost of a special mailing, we decided to forego this year's mini-reunion on Technology Day, Friday, June 5. However, if you are planning to come to the reunion anyway or live in this area, we would like to plan to get together on that day. Drop a line to **Randy Antonsen**, **Ned Collins**, or me so we can arrange something.

I would really like to hear from you — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, MA 02160

36 45th Reunion

Our 45th Reunion is very close. All signs point to a pleasant weekend on the Cape. And for those able to be in Cambridge on Alumni Day only — but not the weekend — we particularly look forward to your presence at the Institute. I, personally, hope to see as many of you as possible at the luncheon on Friday, June 5. My holiday mail included notes from several class members who plan to attend the reunion. A card from Betty and **Fred House** now in Englewood, Fla., begins with "Christmas today needs a split screen . . . Some like it white, we prefer green!" Fred notes that he missed our 40th because he had the misfortune of being hospitalized, and his work for the Badger Co. in previous years took him far afield at reunion times. He and Betty hope to see us this June.

Eli Grossman retired at year's end from the Security Connecticut Life Insurance Co. He and Vivienne plan to stay in nearby Farmington, Conn., at least during 1981. His actuarial career over the years has taken the Grossmans to live in New York, Los Angeles, Rhode Island, Chicago, and Hartford. Eli has written a booklet for people in the life insurance business and is working on a humorous book on life insurance. He welcomes additional material. . . . **Vernon Osgood** writes from Orange, Tex., where he has stayed since retiring from DuPont, that he hasn't seen a classmate since our 40th. The Osgoods travel a lot,

mostly to judge orchid shows.

I regret to report the death of **George Frentzos** in Dallas, Tex., last June. I have no further information except that he leaves a widow, Mary, and his address was 1118 Odeans Dr. (75211).

As I write these notes I can look out across a frozen pond covered with snow, surrounded by hemlocks and mountain laurel, and glistening in the bright sunlight. *But*, the temperature out there is, at the moment, in the vicinity of -10° F (depending on which thermometer you read). By the time you read these notes it will be warmer! Do drop me a line even if it is only one of sympathy. I like cold weather, and I would much rather shovel snow than cut grass, so there. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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David F. Tuttle has been professor emeritus for two years (Stanford University electrical engineering) and is still busy writing and teaching one course. . . . **Alfred Bagg** retired from Eastman Kodak Co., Rochester, N.Y., after 41 years and is now "having fun organizing himself. . . . **Virginius N. Vaughan, Jr.**, joined American Telephone and Telegraph in 1938 and is now engineering director of the Data Communications Standards Network Planning Department. On September 18, 1980, "Virgy" was awarded the honorary doctor of science degree from Randolph Macon, which he attended prior to his transfer to M.I.T. . . . **Harry B. Goodwin**, 1570 San Carlos Bay Dr., Sanibel, FL 33957, is retired. He writes, "This is a relatively quiet and uneventful year. I continue to teach boating courses and am active in church work. This year I acquired a personal computer and am 'having a ball' with it having gotten into computer programming some during my working years. Wife Mell is still very active as a professional artist and can't keep up with orders for her paintings. One son is starting his own home improvement business, and our youngest daughter is studying veterinary medicine."

Ed Corea, 14 Main St., Hingham, MA 02043, retired from the Navy Department as a ship electrical design engineer. He has made a grant request entitled, "Solar Domestic Hot Water Generation for Senior Housing." His clubs are Senior Citizens, M.I.T. Alumni, Boston Section, Association of Retired Government Employees, and Charles River Wheelmen. His travels have included Germany, Italy, Austria, California, and Washington, D.C. His retirement plans are catching up on home projects, volunteering, and visiting classmates. His wife's main interests include knitting, sewing, rugbraiding, dancing, and languages. One son and four of six daughters married, and they have eight grandchildren. Ed's special interests are energy conservation and home weatherization, coordinating recruitment of senior volunteers, studying German, Italian, and Spanish, home care and other senior citizen needs, family activites with children and grandchildren, ballroom dancing, gardening, cooking, bicycling, and bowling. — **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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Tice Boissevain writes that he and **Bob Eddy** are still toiling away at Electric Boat. In his spare time, he designed and built a 200-site campground in North Stonington, Conn. For you RV owners, it's Highland Orchards Resort Park. Not having enough to do, last year he picked up an M.S. in administrative science at Rensselaer Polytechnic Institute. He is active in the SPEBSQSA — all barber shop quartet guys know this one.

Having settled down in Brewster, **Barney Oldfield** has joined the distinguished group of M.I.T. alumni on Cape Cod. Norma is working as membership secretary of the Cape Cod Museum of Natural History; however, Barney still has to spend about half of his time in Maryland, as chairman of the board of Medequip, Inc., developers of computer-based medical systems.

Ollie Kangas is totally helpless and is in the Finnish-American Nursing Home, 1800 S. Drive, Lake Worth, FL 33460. Letters would be greatly appreciated. . . . **Bill Miehle** reports that he has now retired and is keeping busy with hiking, studying law, and painting. . . . We lost two more of our classmates: **Elmar Piel** and **Aram Kerkian**. Elmar died of cancer last fall. He was a professor of chemistry at Norwich University, Northfield, Vt. Aram also passed away late last fall in Akron. Aram had been laboratory manager of Akron City Hospital.

By the time you read this, you will have received official announcement of our annual class dinner June 5 at M.I.T.'s Endicott House. Some of us have already made arrangements to stay there that night. If you are interested, contact Don Severance at M.I.T. promptly (there are limited, but excellent, accommocations). — **A. L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Ernest R. Kaswell received the Edward R. Schwarz Lectureship Award of the American Society of Mechanical Engineers, Textile Industries Division. The citation identified Ernie as an individual who made such major contributions to the fields of textile technology, science and engineering that he deserved special recognition by ASME. During the last twenty years only six outstanding individuals have been selected to receive this prestigious award which was established as a tribute to Professor Edward R. Schwarz of MIT.

Stanley Nowlan received the Nuts and Bolts Award from the Air Transport Association of America. The award was for major contributions to the industry's move from the empirical "hard time" overhaul of the piston age to the innovative reliability controlled maintenance procedures of the jet age, which resulted in improving the economics of airline maintenance while assuring the highest levels of safety.

Lillian and **Warren Evans** enjoy residence near Oakland, Calif., where Warren is manager of contracts and administration for Kaiser Engineers Power Corp. Warren's major involvements include the design and construction of nuclear and fossil fuel power plants. . . . **Dave Lindberg** retired from Pacific Telephone Co. Dave and Ellen completed a ten-week Euro-Rail tour of southern Europe. They visited from Turkey to southwest Portugal. After their return, Dave was appointed to his third four-year term as member of the Sacramento County Juvenile Justice and Delinquency Prevention Commission. . . . **Bob Touzalin** and Aletta occasionally interrupt their golfing in southern Florida to travel. One recent cross-counry trip included Virginia, Oklahoma, Illinois, and California, where their children now reside. At the moment they are traveling in England, Spain, and Italy. If the truth were to become known we might find them impressing some Europeans, Aletta golfing at 88-96 and Bob sporting a five handicap.

Don Severance, '38, writes: "Here it is only December 13 and last night we had our second snow storm. Don't you miss it?" Our answer to Don from this "Garden Spot of the Universe" is that four days ago we watched on TV a football game played in Cleveland where players and spectators somehow endured several hours in zero degrees Farenheit with a chill factor of minus 30 degrees! Yesterday Hilda and I played 18 holes on a course overlooking the Pacific, and my uniform for that game included Bermuda shorts, a short-sleeved shirt, and sunburn lotion. Enufsaid, Don? — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, CA 92037

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Ed Bernard, our class treasurer, reports that all 40th Reunion bills have been paid, leaving a small balance to begin our fund for the 45th. He would like your comments with regard to instituting a small five dollar annual dues fee, which would provide revenue for printing and mailing and for the big plans which our class president, **Norm Klivans**, has for making our 45th Reunion one which we will never forget. Please send me your thoughts on this. A postcard will suffice.

Ed also indicated that he was recently awarded the Bronze Medal by the U.S. Environmental Protection Agency for his work in establishment of the Senior Environmental Employment Corp.

Two feature articles in the *Wall Street Journal* gave **John Casey**, newly named chairman, president, and chief executive officer of Braniff International, very favorable recommendations for the difficult task he faces in pulling this company out of its financial difficulties. Good luck, John! . . . A note from Anne and **Joe Paine** indicates that he is still busily occupied as vice-president and director of MRC Corp., Hunt Valley, Md. Anne is with the Munsell Color Co. . . . **John Klock** writes that he has retired from Ethel Corp., and will spend his time in civic activities, traveling and visiting children in San Francisco and Huntsville, Ala. . . . Ellie and **John McKee** report that they often think of the fun at our last reunion, and they shared pictures and souvenirs with the **William Kathers**, **Marshall Bearces**, and **Hal Davis** at a gathering this past summer. They were indeed sorry that they had not attended . . . remember our 45th is just around the corner!

J. Herbert Hollomon, director of the Center for Policy Alternatives at M.I.T., was named a director of the business equipment manufacturer, Bell and Howell Co., Chicago, Ill. . . . **Donald F. Monell** is still practicing in the field of architecture in Gloucester, Mass. He is specializing in the field of energy conservation, his interest in this field having begun with work for the M.I.T. Solar Research Committee in the fifties.

John B. Simpson retired last year as executive vice-president of Consumers Power Co., Jackson, Mich., and is currently president of Northern Michigan Exploration Co. . . . **David B. Hoisington** retired from the Naval Postgraduate School, Monterey, Calif., and moved to San Juan Island last December so that he might enjoy the sailing and fishing. Recently he has been traveling extensively in the U.S. and Europe as an electronic warfare consultant.

Please send me news of your activities and let me know your thoughts regarding the dues proposed by our treasurer. — **Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030; (617) 785-0540

42

First, congratulations on promotions and similar stuff. **Bert Clear** was promoted from president to vice-chairman of the board of Stanley Works in New Britain, Conn., and **Leopold Wyler**, who is chairman and chief executive officer of TRE Corp. in Los Angeles has been elected director of the corporation. . . . **Bob Cunningham** continues his work for the World Meteorological Organization in both Geneva and Spain as field coordinator of the international experiments concerning cloud position and weather modification.

There was a big article in the October 1980 *Bell Laboratories Record* by **Francis DiSalvo** about batteries with better potential (some pun) than those currently in commercial production being designed from novel compounds and components. Fran has been with Bell Labs since 1971 and works in the Solid State Chemicals and Research Department. . . . **Steve Stephanou** reports that he ran into **Bob Keating** some time ago and that Bob is manager of operations analysis for Susquehanna Corp. and is working out of the Los Angeles office. . . . **Jack Flipse** has been

at Texas A&M for three years and is now a tenured full professor in civil and ocean engineering and a member of the graduate faculty. Apparently his graduate course in ocean mining is very attractive and the board of regents has also started a naval architecture program. Our congratulations for Jack in getting this landlocked college interested in oceanics! . . . From **Bernie LeVere**, an update telling about his and Zelda's recent trip to China, Inner Mongolia, and other cities in the extreme northwest of China beyond Peking. He says that it was very fascinating, which is probably an understatement.

Al (The Tailor) Golden is still tilling the fields as a corporate development consultant concentrating on alternative energy systems. He is also a trustee of the City Club of New York, chairman of the Energy Policy Committee of the New York State Senate Advisory Council to the Democrats (that's some title), a member of the National Administrative and New York Administrative Committees and the Energy Sub-Committee of the Jewish Labor Committee, and a member of the National Energy Commission of the Americans for Democratic Action. Outside of that, he spends his life "going to meetings and seminars and writing reports." Al, thanks for the dossier.

Charlie Smith reports on the arrival of his first granddaughter (he already has four grandsons). He tells us about his trip to Geneva as the U.S. employer delegate to the International Labor Conference. This is the specialized agency of the United Nations which our government has recently rejoined after dropping out in 1977. Charlie doesn't mention his booming business in Cleveland, but perhaps by now it runs on its own steam.

Pete Sloss, writing from Deerfield, Ill., says that he is still out there selling data communications (modems, multiplexors, line monitors, terminals, etc.). Pete reports running into **Warren Twaddle** who is still holding forth at Amoco.

Bill Dennen, from the University of Kentucky, says that he is looking forward to retirement in about five years; he's kept his house in Nahant and is planning a sabbatical including Mexico, Australia and Scotland for next year. Briefly, all of his children have married; Charlotte is still active with gardening, needlepoint and superb cookery; and they have "1.5 grandchildren." Bill, I don't quite understand the statistics. Perhaps you can fill us in. — **Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

43

Jerome Wiesner, former president of M.I.T., was awarded the Order of Boyaca at the Colombian embassy in Washington, D.C., on October 2. Making the presentation was **Virgilio Barco-Vargas**, Colombian ambassador to the United States and a former member of the M.I.T. Corporation. . . . **Dick Henning**, a retired Navy captain in Medfield, Mass., sends us considerable information about his children (two M.I.T. alumni sons and a Wellesley freshman daughter) but nothing about himself or wife Jean. Come on, Dick, you can do better than that. . . . **Stewart Hill**, Course II, writes from Sherrill, N.Y., as follows: "Retired from my job at Oneida Ltd. in March 1978. Am really enjoying having some free time for sailing — racing and cruising — in the summer and skiing in the winter, plus some traveling. Number six grandchild was born October 23."

Donald Stevens, Course VI, checks in from Berrien Springs, Mich. He, too, is retired, and stays busy flying a small plane all over North America. . . . Announced in November was the four-year appointment by President Carter of Chicago architect **Walter A. Netsch** to the Commission on Fine Arts. . . . A November news release from the Instrument Society of America reports the election of **Henry Steinhauer, Jr.**, to the distinguished grade of ISA Fellow. Hank is currently a principal engineer with the Goodyear Atomic Corp., serving as a technical advisor at Oak Ridge. His citation was for distinguished achievements in the development and application of analytical instrumentation in uranium enrichment processes. . . . Thanks for a good news month. — **Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

One of the rewards gained from starting a new year, be it calendar, fiscal, religious, Chinese, or solar, is the opportunity to clean up the desk and discover those "things undone." As we started the growing season here in the Northeast, my spring cleaning unearthed a small notebook I carried the day Paul Gray was installed as president. In this notebook **Paul Heilman**, a former class secretary, had written that all was well in the brass forgings business and that he was on his way to a week in California looking for even more brass sales. Their (his and wife Maudi's) new house in Westport was just taking shape after two years with still much to do. Their daughter (Maritza) had married a Delaware boy and was living in Bear, and their son (Paul) was finishing up in electrical engineering at Georgia Tech.

Daniel F. Lord added to his Alumni Fund envelope: "My permanent 'project' in turning 125 acres of typical New England land, with a nearly mature forest plus buildings, into the 'farm' of the future. Briefly, renewable resources are based on maximum use of solar energy, applied to biomass, with the optimum undertanding and use of the Second Law. This 'farm' is only 30 miles from M.I.T., and, since the project involves far more than one person can handle, I would like to hear from anyone in the M.I.T. community who has any ideas or interest in the matter." (Anyone interested can write him at 243 Green St., Marblehead, MA 01945).

A press release from the Michigan State Chamber of Commerce noted that **John H. Burdakin** had been elected to its board of directors. In 1976 he was appointed president of Grand Trunk Corp., the parent company of all Canadian National Railways Co. operations in the U.S. He is also president of the Grand Trunk Western Railroad, the Detroit Toledo Ironton Railroad, the Central Vermont Railway, and the Duluth, Winnipeg and Pacific Railway. He also is a member of the Michigan Job and Authority Development, member of the board of directors of the Belt Railway Co. of Chicago, the Greater Detroit Chamber of Commerce, the Boys Club of Metropolitan Detroit, and the Advisory Committee of the Economic Club of Detroit. He and his wife Jean have three sons and reside in Bloomfield Township.

Arturo M. Morales wrote that on October 24, 1980, he was named distinguished member of the Society of Mining Engineers of the American Institute of Mining Engineers. He is also included in Marquis *Who's Who in the World*.

The July issue will report on Arturo's success in guiding your classmates in Mexico City during the 33rd Annual M.I.T. Fiesta.

Up in this corner of the U.S., we are enjoying the occasional promises of warmer weather to come. Remember the sunbathers on the Charles? (or the Great Court?) — **Melissa Teixeira**, Secretary, 92 Webster Pk., West Newton, MA 02165

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The following notes and comments come from the reunion mailing that Prexy **Gerry Quinnan** thrust in my direction at the Cape last June. **William H. (Slim) Pasfield** continues at St. John's University where he has completed 22 years in the Chemistry Department. . . . **Warren H. Miller** continues in the family grease and oil business in North Tonawanda, N.Y.; it has been several years since we've seen Warren in Cambridge. . . . **William G. Martin, Jr.**, was, as you will recall, a reunion attendee along with wife Jeanne. Early last year, Bill retired from his long-time employer, Johnson Services, only to start, on July 1, 1979, Martin and Associates, an energy management consultant firm representing, among other things, Computer Controls Corp. of Wilmington, Mass., in the greater New York City area. His three oldest children are married. Lynne is in medical research with her husband at SEC in Washington; Elizabeth, a Tufts medical graduate, is mother of two living in Wellesley. William G. III is a senior at Georgetown Medical School, and young Pete is a senior at Colgate in Hamilton, N.Y. Bill and Jeanne continue to live in Darien, Conn.

Manuel A. Cadenas continues to live in Coral Cables, Fla., while **Matthew B. Harrington, Jr.**, Houston based Shell oiler, now pays class dues — a Weymouth first! . . . **Francis J. X. Donohue** of Longmeadow, Mass., continues as lab director at Tampex, Inc., in Springfield. Wife Jane reports that Frank's four children and her two range in age from 22 to 32, and all live in New England along with three grandchildren. . . . **Al Oxenham**, now a Manhattan resident, threatened to attend our 35th with his several dogs. Al did not honor this threat. However, **Chris Boland** has promised to follow through with Al; hopefully, we will have a report soon. **Emmett E. Day**, professor of mechanical engineering at the University of Washington, had reunion reservations; we must conclude that volcanic activity caused a last minute change in plans. . . . **Robert E. Wilson** of Bala Cynwyd, Penn., came up with an excellent reunion suggestion: slides and pictures of the good old days. (Prexy Gerry, you should remember this in 1985.) . . . Bob and Nina were unable to attend the reunion — two graduations plus one wedding during this time period. . . . **Thomas S. Markey** of Glencoe, Ill., had a family wedding; no wonder he didn't attend. . . . And $10 class dues from **Hartmann J. Kircher** of Sparta, N.J. Our last report on Hart had him commuting weekly to either Republic, Grumann, or out on Long Island.

Yes, I'm certain several individuals have not been mentioned, but who's to say that Quinnan gave me all the questionnaires. Next month we shall continue to update you on reunion attendees who have not yet been covered in detail. One most important item — our learned professorial friend from Princeton (and a most regular reunion attendee), **Arthur E. Miller**, was unable to find Wychmere Harbor on a Cape Cod road map; he should have tried a Nantucket south chart!

The foregoing were written last June on an Eastern flight between Boston and Miami; it is now early January and a wee frigid here in New Castle. While cleaning out my desk earlier today, I stumbled upon the following "old" items from late 1978, early 1979: **James W. Shearer** at the time was still involved with magnetic fusion research. . . . **Alvin S. Cohen** had sold his Rhodes 19 "after winning much Long Island Sound silver" and had taken up golf; he was still an executive vice-president of Campus Sweater and Sportswear, a division of Interco, Inc.; son Mark, '74, had graduated from Columbia Medical School and was interning with his intern bride at University Hospital, Ann Arbor, Mich. . . . Rev. **Charles J. Hooker** was a member of the board of directors of Murgas Amateur Rodeo Club, named after Rev. Joseph Murgas, developer of the Murgas tone system, a forerunner of today's data transmission systems.

And before closing we must make a couple of 1978-1980 Christmas card comparisons! In 1978 Edna Strnad reported that Nina had become a research assistant at Harvard Med, Lyse was working at University Hospital in Cleveland between her second and third years at medical school, and Jeff was working as an officer of the *Yale Law Journal*. There was an additional note that "our kids got cleaned up since the 1970 card!" In 1980, we had a beautiful family picture of the wedding of Lyse and Tom Leavenworth May 24, 1980; the two doctor newlyweds are now interning at the University of Iowa Medical Complex in Iowa City. The male wedding uniform — striped tie, blue blazer, tan trousers, and loafers — was great. Even dear old dad, **J. J. Strnad**, now looks handsome!

In 1978 **George Bickford** reported that Betty was still teaching to help the education crunch, with Rob a senior at Colgate and the two girls working and taking courses towards their masters'. George continues in charge of all Carrier's warehouse operations nationwide. In 1980, the following: "It's been a big year for us! Our oldest, Susan, graduated from Pratt Institute with a MFA and was elected to the board of Pratt for two years. Pamla wed and is now a mother — our first grandchild." More Christmas notes next month. — **Clinton H. Springer**, Secretary, Box 288, New Castle, NH 03854

46 35th Reunion

Our reunion committee has been beavering away in preparation for on-campus activities (Thursday-Friday, June 4-5), as well as the post-Technology Day off-campus weekend outing (Friday-Sunday, June 5-7) at the Woodstock Inn in Woodstock, Vt. **Bob Spoerl**, **Herb Oedel**, **Gene Parish**, **Don Hurter**, **Ted Heuchling**, **John Gunnarson**, **Mort Bromfield**, and **Jim Goldstein** are planning a rousing 35th for all who attend. From Tech Night at the Pops, to a vintage New England village, and a bracing dinner conversation with the inimitable dramatist, **Curt Canfield**, the reunion will be memorable. Now is the time to let **John Gunnarson** know that you're coming by returning the pre-registration forms recently mailed to you. I have attended all but one of the reunions and can say each was different and all were just marvelous. We took most of the family to the last three reunions, and my wife and children thought they were wonderful also.

Dr. **Samuel Meerbaum** in recent times has worked in research in the fields of cardiology and cardiovascular physiology. This has led to significant developments in quantitative echo cardiography and retrograde coronary venous treatment of severe heart failure. The doctor hopes that with his staff and colleagues they can intensify their efforts with the aim of earliest detection, diagnosis, evaluation and correction of life threatening or debilitating cardiac failure.

It is with regreat we must report the death of **Walter D. Nolte**, September 30, 1980. Mr. Nolte had been vice-president of the Dictaphone Corp. in Rye, N.Y. Mr. Nolte had attended San Diego State College before graduation from M.I.T. in 1946. Mr. Nolte of Fairfield, Conn., is survived by his wife, Mrs. Carolyn M. Nolte, four sons, one daughter, and two granddaughters. Until next time. — **Russell K. Dostal**, Secretary, 18837 Palm Circle, Cleveland, OH 44126

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In December our class had a delightful gathering at M.I.T.'s Endicott House in Dedham. Those attending included Judy and **Graham Sterling**, Rose and **Leon LaFreniere**, Genie and **Dave Finnegan**, Anita and **Verity Smith**, Jean and **Milton Slade**, **George Clifford**, **Bob Bliss**, Dorothy Seltzer, Eleanor and **Harry Ottobrini**, Barbara and **Warren Wells**, Gloria and **Sonny Monosson**, Nancy and **Don Noble**, and yours truly. Nancy and Don arranged for Sue Krueger to sing and play the guitar after dinner. Sue's repertoire ranged from Christmas carols to ballads.

Ken Brock sent a note saying that he and Ann wished everyone at our mid-winter meeting the very best. . . . **Ed Kosower** spent 1977-78 on sabbatical as J. S. Guggenheim fellow and visiting professor at the University of California, San Diego, and at the University of California, Berkeley. Then he was Japan Society for Promotion of Science visiting professor at Kyoto University. Ed is deeply involved in research on a new series of heterocyclic compounds called bimanes. His research is in chemistry and photophysics working with his wife, Professor Nechama S. Kosower, biology.

Bertin Posthill is presently product support manager at Burroughs/Plymouth and yearning to return to California. His wife, Sally, is a paralegal in Ann Arbor. Son, John, is pursuing a doctorate at Oxford. Daughter, Ann, and son, Mark, are studying in California. . . . **Robert Welsh**, executive vice-president of Ludlow Corp. in Needham Heights, Mass., was named vice-chairman of this maker of papers, packaging, and home furnishing products. . . . **Robert Vader** has retired from his position as president of Lockheed Aircraft Service Co. Bob lives in Burbank, Calif. . . . **Sydney L. Crook** has returned to Avco Systems Division after seven years at Raytheon. He will be conducting systems requirements analysis for the reentry system of the MX missile.

I have formed my own corporation, Barrington Management Corp., to operate an equipment leasing business. I plan to locate several investors interested in using the depreciation write-off to shelter the income from the leases they will own. My corporation will manage the leasing operation which involves collecting the rent, servicing the equipment, and paying the investor his return. The equipment is a home draft beer bar that is sold nationally, although initially I will be buying leases for Rhode Island. — **Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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Peter Stein, his surname an acronym of his motto — *S*uccess *T*hrough *E*ngineered *I*nstrumentatio*N*, has built a life-work-of-love "running around the world lecturing on the 'Unified Approach to the Engineering of Measuring Systems.' " After five years teaching at Tech, four years as instrumentation engineer at AiResearch Manufacturing in Phoenix, and 18 years as professor of engineering at Arizona State, Peter is now devoting full time to his Stein Engineering Services, Inc., also in Phoenix. He has been elected a fellow and been presented with an educator award from both the Society for Experimental Stress Analysis and the Instrument Society of America. In his spare time, Peter publishes an alumni newsletter for the 950 students he had at ASU.

Lee Davies has celebrated his 25th year with SRI International. . . . **Robert Steinhart** is a senior marketing representative with IBM and also just had his silver anniversary with his company. . . . **William Symonds** has been president of the N.E. Trawler Equipment Co. for 15 years. . . . **Walter Seibert** is vice-president of the Mining Chemical Bank. . . . **Beale Wilson** is a well-known Boston architect. . . . **Emmert Lowry** is on IBM's faculty loan program. He is teaching economics, statistics, and production management at Bethune Cookman College in Daytona Beach. He and Alice have enjoyed getting involved again with campus life and activities: "Just like Westgate West." They have hung out the "y'all come" sign for all Tech friends who find themselves in Daytona. . . . **Jack Fogarty**, living in Columbia, Md., is still with Westinghouse Advanced-Technology Lab, and is now working on "silicon chips" for radar. — **Paul E. Weamer**, Secretary, 5130 Regent St., Madison, WI 53705

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Donald J. Eberly transferred this past summer from ACTION, where he had been for nine years, to the Selective Service System where he is working on the alternative service program for conscientious objectors. . . . **Sam Tennant** is presently vice-president, development group, at Aerospace Corp.'s college relations office in El Segundo, Calif. . . . It was nice to hear from **Dick Counihan**, who writes to say that he really treasures *Technology Review*.

Edwin Kruse would like to know if anyone attended the Republican or Democratic National Conventions. He also want to know if any classmates hold elected or appointed government positions (federal, state, county, or local). Ed states that it seems to him that our class members (at least as represented in the notes in the *Review*) are so busy with the business of making money that no one is involved with government, except for paying taxes. . . . **Joseph B. Oppenheim** is taking a course in political science at Brevard Community College. . . . **Richard H. Johnson** is presently a controls engineer at Saginaw Steering Gear, a division of GM in Saginaw, Mich.

A. Craig Hood, now in his 20th year at SPS Technologies, has been named manager of new technology development. He will identify and evaluate the feasibility of high technology businesses outside SPS's current division charters. Most recently, he served as general manager in the company's Special Products Division. Also, he is a member and past chairman of the American Society for Metals, Philadelphia chapter, and holds memberships in the American Institute of Mining and Metallurgy and the Society of Automotive Engineers, among other organizations. Hood was elected Fellow of ASM in 1975. He has lectured before national technical societies in the U.S.A., Europe, Japan, and the Soviet Union. He has taught metallurgy at Penn State and the local ASM chapter. He and his family live in Wayne, Penn.

In updating our alumni records, we were saddened to hear of the death of **Casper Ranger III**, who died in 1975. . . . **Jack C. Acton** of Fairfield, Conn., has been staff executive, technology, for General Electric's Industrial Products and Components Sector since 1979. Jack joined GE in 1950 and held positions in engineering, finance, manufacturing, and sales in a number of industrial departments before being named program manager, Minuteman Electrical System. He later served as manager, engineering, for Aerospace Motor and Generator, and later the Aerospace Instruments and Control Systems Department. From 1972 to 1975, he was general manager, Housewares Engineering Department; and from 1975 to 1978, he was president and general manager, General Electric de Mexico, S.A., as well as GE's national executive for Mexico. In addition to overseeing advanced technology programs underway at some four dozen GE components in the Sector, Jack, since last fall, has also been chairman of the Sector's Productivity Council and editorial director of the company's first productivity newsletter. — **John T. McKenna, Jr.**, Secretary, 1 Emerson Place, Apt. 11H, Boston, MA 02114

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The Emhart Corp., Farmington, Conn., has announced that **John S. Rydz** has become director of productivity for Emhart, a diversified manufacturer. John was formerly vice-president of Singer Co.'s sewing products group and director of Singer's corporate office of innovation. . . . **Robert A. Boole** has been named director, venture analysis, of Analog Devices, Inc., Norwood, Mass., a maker of computerized control equipment. . . . GenRad has named **Harold McAleer** as senior vice-president. Hal is also division board chairman of the Acoustic Vibration Analysis Division reporting to William Thurston, chairman.

Charles A. Honigsberg writes that he has joined the Chemical Plants Division of Dravo Corp. He and his wife Marilyn have moved into the city of Pittsburgh from the suburb of Monroeville. Charles' son, David, graduated from the University of Hartford and his son, Michael, is a second-year student at the University of Chicago. . . . Another classmate with college financial problems is **Eugene J. Rapperport** who writes, "With two and one-half kids in college, I had to send my wife back to work and run my consulting business a little bit harder." . . . In November 1979 **William T. Whittington** became the new plant manager for the Hubbard (Ohio) Facility of Valley Mould and Iron Co., a division of Microdot (which is a subsidiary of Northeast Industries).

Werner Kahn writes that he is still enjoying his

assignment in Rio de Janerio, Brazil, and reporting into the Gulf office in Houston, Tex. He has recently been given the title of manager of international business development for Gulf Refining and Marketing Co., International Lube Oil Division. As the title indicates, Warner has kept up a very intensive international traveling schedule, having been to Houston already eight times this year alone, not to mention other places. . . . Colonel **Richard C. Wingerson** (retired?) is continuing to serve on the County Planning Commission and was elected to the board of directors of the local fire protection district. Simultaneously he has established a new business for design and installation of solar heating systems. Despite all this activity, he is continuing to enjoy retirement in the Colorado high country and is celebrating the birth of his first grandchild.

Claude K. Jones of 14 Arrowhead Rd., Marblehead, MA 01945, passed away on June 24, 1978. Dr. Jones was associated with the medium steam turbine business of GE in Lynn, Mass. — **Arthur S. Turner**, Secretary 175 Lowell St., Carlisle, MA 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, CA 94301

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We received a note from **Fred Rubel** concerning a company he cofounded, Rubel and Hager, Inc., which offers a broad range of capabilities in the environmental consulting field throughout the U.S. and overseas. The firm was founded in 1971 and has its offices in Tuscon, Ariz. Fred has pioneered equipment development and new applications for reverse osmosis systems and the use of activated alumina in water treatment. His achievements have been published in leading periodicals and EPA technology reports.

Ron Kurtz was recently named president of the Refractory Metals Association. This association, a trade division of the Metal Powder Industries Federation, represents miners, processors, and fabricators of refactory metals, such as tungsten, molybdenum, tantalum, rhenium, and columbium. Ron is also president of Kulite Tungsten located at Ridgefield, N.J. Kulite makes tungsten and tungsten alloy parts from metal powders for the aircraft, nuclear, aerospace, medical, and sporting goods field. Ron lives with his wife Carol and three children in Englewood, N.J.

Dom Sama, one of our secretaries, reports that the University of Lowell Chemical Engineering Department has received an award from the Department of Energy to study solar distillation of ethanol in general. In particular, the study involves the development of a multi-stage solar distillation concept. Dom and a fellow M.I.T. alumnus, Karl Slade, '62, are involved in this project. Dom also reports that he's off to Colombia right after the first of the year with his wife, and hopefully he will have some interesting words for us upon his return.

We have received information from an undisclosed source that **Bob Rohner** recently celebrated his 25th year with Stone and Webster. The last word that we had was that Bob was manager of the Process Industries Group.

The news this month is rather sparse and we therefore encourage you to please send us any information that would be of interest to our class. — Secretaries: **William Combs**, 120 West Newton, Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 08101; **Louis E. Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; Dr. **Dominick Sama**, Chestnut Hill Rd., Groton, MA 01450

56 25th Reunion

We hope by now you and your family are well scheduled for the once-in-a-life event — our 25th Reunion. There's something in it for everyone — a professional update seminar, Pops concert, spectacular Cape Cod beach party, plus (the purpose of it all) plenty of re-uning. The major fund drive for the Class of '56, the Sam Mason Career Development Professorship, is making good progress — with still some push needed to surpass our goal of $500,000. A pledge payable over the next five years will count fully towards this important class gift. As you've seen in the mailings for this gift, the Career Development Professorship is a particularly sensible and much needed contribution to the Institute. The income from this endowment gift will support short-term appointments of young untenured exceptional faculty during what is often the most productive years of their careers. The short appointments will serve a long series of young faculty, a fitting memorial for that friend of so many of us in '56, Sam Mason.

Robert Sawyer is head of preventive and occupational medicine at Yale, and also on the faculty at Mt. Sinai Hospital in New York. He is a consultant for government and industry on toxic material control and personnel protection. He is still renovating an old beach house in Guilford, Conn. . . . **Peter Bulkeley** joined Hech-El Industries last September, as vice-president and director of technical operations. Peter had been dean of engineering and technology at Bradley University in Peoria, Ill., since 1972. Before that he was associate chairman of mechanical engineering at Stanford, where he received his doctorate.

Forbes T. Brown has been a professor at Lehigh since 1970, where he recently became director of a new research program in fluid power and fluidics. He has four M.I.T. degrees, including an Sc.D. in 1962, and is active in the Fluidics Committee of ASME.

Walter Frey completed another trip thru the Far East last fall, and helped instigate starts towards M.I.T. Alumni Clubs in Hong Kong, Peking, Singapore, and Melbourne. Walt visited with Professor Sun, '47, in Peking, where a student exchange program has been started with M.I.T. — Co-Secretaries: **Warren G. Briggs**, 33 Bancroft Rd., Wellesley, MA 02181; **Bruce B. Bredehoft**, 7100 Lanham Dr., Edina, MN 55435

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My apologies for the long silence — have been traveling extensively and the news is just catching up to me!

A press release from the University of California, Irvine, advises that **Edward B. Roberts**, David Sarnoff Professor of the Alfred P. Sloan School of Management at M.I.T. is an editorial council member of the first Western magazine to be publicly distributed in the People's Republic of China in 30 years. . . . **Ira Holtzman** is on site assignment for the MITRE Corp. at AFCENT headquarters in Brunssum, the Netherlands. He is working with representatives of 11 NATO countries on the implementation of the AWACS aircraft. His wife Margot is teaching English and his two children are attending an international school. . . . **Malcolm L. Singerman** sends news that he is currently president of Barton Personnel Systems, Inc., with headquarters in Allentown, Penn. The company specializes in recruiting in the data processing and engineering fields. He is married and living in Hunterdon County, N.J. He has two girls who attend school, one in grade school here in the states, and one in high school in Coleraine, Northern Ireland.

Lawrence R. Hoover, director of tariffs, rates, and contracts at Ohio Power Co., a Canton-based subsidiary of this utility holding company, was elected a vice-president of Ohio Power. . . . **James E. Cunningham** (Jim) writes: "Have moved from vice-president, engineering to a newly created post of vice-president, product research at Docutal Corp. My young family is doing well here in Dallas, though we miss our many friends in the Boston area. Amy in the fifth grade and Susan in the first grade sure help to keep your mind on basics. The world of electronics banking is moving rapidly and, as the regulations slowly permit, is helping to stem the flow of paper which is increasingly expensive and inflexible to deal

with in highly automated ways." . . . **Gerald M. Sapers** writes that his son Steven has returned to the greater Boston area after an absence of 12 years as a freshman at Brandeis University.

A copy of an intriguing article entitled, "The Scientific Search For The Elusive Quark," featuring **Benson T. Chertok** from the September 1980 issue of *American Inquiry* makes interesting reading. Sorry it is too long and detailed to capsulize for our readers . . . a synopsis could not do justice. — **Fred Morefield**, Secretary, Shared Medical Systems, 650 Park Ave., King of Prussia, PA 19406

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Prospects of spring have apparently thawed the pens of our classmates, as we have a full mailbag this month. Lots of news arrived from offshore, including this note from **Bob Baber**: "Since 1975, I have been an independent management consultant, specializing in information systems for management and business applications, and in materials management. Prior to 1975, I was employed by a management consulting firm and by a computer consultancy. My wife Ursula and I have two children aged 11 and 14. We have been living in Bad Homburg, Germany, for 16 years."

Jamie Rosenthal has become CEO and president of Inversiones Continental, S.A., a holding company with subsidiaries in banking, insurance, leasing, finance, brokerage, sugar, newspapers, and real estate. As one of the largest corporations in Honduras, Continental Group also holds minority interests in hotels, airlines, construction and supermarkets. . . . **Andrew Deutsch** serves as president and CEO of a group of companies in Buenos Aires, Argentina, including Tia, S.A., INTA, S.A., Sofor, S.A., and La Rotunda, Saf. He is also active in Continental Capital Corp. and serves as its vice-president and secretary. . . . **Vic Klemas** continues his work as a consultant to the UN, the National Science Foundation, and others in providing marine technology assistance to developing countries. He is also active on the Ocean Policy Committee of the National Academy of Sciences. . . . **David DuFour** has been with Polaroid for the past four years where he is now director of sales for the Professional Products Division. Prior to that, he spent 18 years at Westinghouse Electric in various marketing positions both in the U.S. and overseas. This past fall, he was a speaker at the fall seminar of the Photo Marketing Association. . . . **Eugene Zuch** was recently promoted to director of marketing at Datel-Intersil, a manufacturer of data acquisition circuits and systems. Formerly "Datel Systems," the company was acquired by Intersil, Inc., in April 1979.

During his second year as an independent consultant, **Bob Parente** writes, "So far this year, I have appeared as an expert witness before the Pennsylvania Commission on Three-Mile Island and for the Department of Energy regarding power companies located in New Mexico and

Arizona. With my second anniversary now past, I'm looking forward to the third." . . . Out in the media world, **Stan Klein** is now publisher and editorial director of *The Harvard Newsletter on Computer Graphics*. — **Michael E. Brose**, Secretary, 59 Rutland Square, Boston, MA 02118

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Hello, again. It seems that every time I turn around another column is due. But the mailbag is staying full, so at least I do not feel that I am writing in vain. However, I never will get over writing a column several months in advance. It is Christmas weekend at the time of this writing with an outside temperature of about 15 degrees F, and you won't be reading the column until April.

Mike Nash (Course X) writes that he is president and chief executive officer of Crestek, Inc., a small technology-based company. Specifically, his company specializes in the application of ultrasonic energy in industrial cleaning and semiconductor bonding. He is actively in pursuit of related small enterprises to acquire. Any candidates? . . . **Neil Harper** (Course I) also writes that he is heading his own company. It is a 35-person computer-based consulting firm located in the Fresh Pond area of Cambridge. . . . **Jerry Roylance** writes that he will retire from the Air Force in February 1981 (actually he has already retired — I have to remember that you are reading this in April) and will complete work at Rensselaer Polytechnic Institute for his M.B.A. He then plans to enter the banking field somewhere in the Northeast. I'm sure he would like to hear from any and all classmates who might be able to offer some assistance.

The next letter also comes from a member of the Armed Forces, **George O'Connor** (Course V). George, whom I last saw at our reunion, is presently stationed in Germany as a chemical officer. He is presently a lieutenant colonel but expects to have been promoted to colonel by the time this is in print. . . . **Paul Todd** (Course VII) is still at Penn State as a professor of biophysics and is quite active in planning activities at the NIH's new program for low level radiation research. His eldest son Kevin is studying engineering at Lehigh, while 11-year-old Andrea performs and competes regionally in gymnastics.

Gilbert Chin (Course III) writes to tell of two honors he has received. The first was that of the Chinese Institute of Engineers U.S.A. 1980 Achievement Award for contributions in crystal plasticity and magnetic alloys. The second was that of being elected a fellow of the Metallurgical Society of AIME, which is limited to 100 living members, and to no more than five new members per year. . . . **Alan Bufferd** sent me note (he is good for at least one or two a month) that indicates that **Lawrence G. Roberts** (Course VI) who is president of GTE Telenet Communications, a subsidiary of GTE, has moved to the newly created post of president of GTE CNS Products. . . . The last note comes from **Michael Brunschwig** (Course VI) who writes that he is now a CPA and is manager of the Denver office of Pannell, Kerr, Forster, an international CPA firm with 26 U.S. offices. Their specialty is hotels, clubs, and hospitals.

No more news for now; but keep on writing.

The offer I made (as did **Phil Richardson**) in the last issue is still valid: give a call when you are in the greater New York area and we'll get together to discuss current events and activities. No more news, but keep writing. — **Larry Laben**, Secretary, 310 Rockrimmon Rd., Stamford, CT 06903 (Telephone: bus., (914) 696-5048; home, (203) 322-1028)

61 20th Reunion

The class reunion plans are pretty much set as I write this. As you know from the mailings, our program includes a cocktail party at the crew boathouse on Friday, followed by a trip up the Charles from Boston Harbor on Saturday, and a dinner dance at the spectacular New England Aquarium. Although there was some discussion about serving scrod at the dinner, the idea was rejected because eating fish at an aqarium might be considered cannibalism by the larger fish. A very spiffy breakfast at M.I.T. on Sunday is also part of the package. They promise to have Irish coffee or Bloody Marys that morning. It is not too late to plan to come to Boston for a wonderful and exciting weekend. If you want to make some last minute plans, feel free to call me at home (617-734-9392). I can get phone numbers and addresses of classmates for you on short notice as well.

A couple of interesting notes this month. **Charley Arcand** writes that he now lives near Kansas City, Kans., where he is into engineering. But his major interest seems to go beyond mere engineering. Recently he published an article entitled, "Fritz Redlich, 1892-1978: The Man and the Scholar," in the *American Journal of Economics and Sociology*. As a sideline, Charley is American representative of a Nigerian company called Business Research Management Center that appears to act as a go-between in complex international financial transactions. Charley and his wife Bernadette have two children, Alan (11) and Elizabeth (9), and all are hoping to be in Cambridge for our reunion.

Gus Solomons was the subject of a major article in *Dance* magazine last September. They said that Gus is "a glamorous figure, nationally acclaimed and sought after as a dancer, choreographer, and teacher, closely acquainted with the celebrities in his business and a celebrity himself." Gus has led his own dance company since 1972 and has danced with the big names in American dance — Donald McKayle, Perle Lange, Martha Graham, and Merce Cunningham. He has done extensive choreography for his own company as well as for others including Alvin Ailey. Gus was dean of dance at Cal Arts for several years. A remarkable career for an M.I.T. tool!

Ken Kotovsky still has rotten handwriting but it is possible to make out that he is alive and living in Pittsburgh where he is chairman of the Behavioral Sciences Department at a local community college. I'll bet he is a hell of a good teacher. He says that he has done some research in cognative psychology and is now deep into problem solving. His wife, Avis, is the director of a nursery school and they have two kids, Jack (12) and Laura (14), who are "super" he says. Their dog, Sabaka (age 1), however, is "a pain in the ass."

William Jouris writes as follows: "The family and I are now entering our fifth year in Saudi Arabia. We still enjoy the strangeness of living here as well as the opportunities of travel presented. We will be going to Sri Lanka for a week in November (this was written last September) where I will be a U.S. delegate to the International Atomic Energy Agency symposium on combustion processes in food irradiation. I am president of the Riyadh Aquanauts chapter of the British Sub Aqua Club, the biggest dive club in the Middle East even though we're in the middle of a desert! Anyone passing through Riyadh should give me a call." Thanks for the interesting note, Bill.

Ira Dorf writes that he is now the director of management continuity and development at ITT. He says that he, wife Shelly, and their three kids live out on Long Island. **Arthur Chen** is now manager of the Electrical Systems and Technology Lab at GE in Schenectady, N.Y. Life at GE has been very productive for Arthur: he has 19 papers and nine patents to his name. The Chens live in Niskayuna, N.Y., with their two children, Holly and Alex.

Brian White works at the MITRE Corp. Brian is active in local IEEE affairs and is chairman of the Communications Society Chapter in Boston. The White family includes two children, Andrew (14) and Hilary (10), and they all live in Sudbury, Mass., which is a lovely town.

I hope to see many of you in Cambridge this spring. Do come, it will be a pleasant way to spend a lovely June weekend. You can show your kids your old stomping grounds and compare notes with some old friends and make some new ones. — **Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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Starting with the international news, **Lane Anderson** is principal cellist with the Monte Carlo Philharmonic Orchestra. He and his violinist wife Renee are part of the Pro Arte Piano Quintet of Monte Carlo which has performed twice at the Isabella Gardiner Museum in Boston. They have two sons, David, 2, and Noel, 1. . . . **Jerome A. Winston** is coordinator of a graduate program in human services at Preston Institute of Technology in Melbourne and editor of a newsletter for Australian human service evaluators. Cross country skiing and grade one rock climbing are his favorite outdoor activities. During his trip to the U.S. a year ago he talked to **Norman Soloway**. . . . **James W. Kesler** was married in Belgium in March 1980. He was transferred to Washington by the State Department and lives in Virginia with his wife Renny and children, Nancy, 16, Bob, 12, Philippe, 8, and Christine, 5. . . . **Harold Waller** is currently chairman of the political science department at McGill University.

On the domestic scene, **Steven J. Smith** is now executive vice-president for operations of Ryan Homes, Inc., in Pittsburgh. . . . **Michael F. Parlamis** is president of Frank Parlamis, Inc., and Hermes Construction Corp. He is also treasurer and co-founder of Bridge Cellars, Inc., which has leased two arches under the Brooklyn Bridge. He is contemplating building a wine shop, museum, and restaurant there prior to the bridge's 100th anniversary in May 1983. . . . **John A. Rollwagen** who is president of Cray Research, Inc., in Minneapolis has also been elected chief executive officer. . . . **Henry N. McCarl** is a member of the board of directors of the Society of Mining Engineers of the AIME and presented a paper at the 11th World Energy Conference in Munich last year. . . . **Erich K. Bender** has been named a divisional vice-president for environmental and noise control technologies at Bolt, Beranek, and Newman, Inc. . . . **John S. Yuan** has joined the Pitney Bowes corporate staff as manager of corporate business analysis. He was previously with ITT and lives with his wife Barbara and two children in Croton-on-Hudson, N.Y.

On the academic scene, **Kenneth A. Rahn** is an associate professor at the Graduate School of Oceanography, University of Rhode Island where he has been since 1973. His research is in the arctic aerosol and long-range transport of air pollutants. He and his wife Julie have two children, ages 4 and 7. . . . **Theodore Sheskin** was promoted to associate professor with tenure in industrial engineering at Cleveland State University. He writes that he is still single and that he purchased a house last year. . . . **Peter G. Anderson** is now a professor at the Rochester Institute of Technology in computer science. Previously he was department chairman at Seton Hall University. He writes that not having to commute 80 miles is nice for him, his wife Jane, son Scott, 16, and daughter Julie, 13. — **John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

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This month I have an amazing statistic to report — I actually received more letters from you directly than I did through Alumni Fund envelope flaps! Of course that doesn't mean a particularly long and newsy set of notes, since I only had one envelope flap — from **Stan Diamond**. He reports that after nearly 14 years at the Harvard Observatory, his job blew away with the cancellation of the contract supporting the observatory. Stan landed on his feet at Raytheon's Missile Systems Division

where he is a section manager in an electro-optics laboratory. Occasionally he runs into **Matt Fasset**, who has 19 writer's or inventor's awards in his Raytheon career. Stan has one so far in his two years at Raytheon. He is living in a large, drafty old house in Malden, Mass., with his wife Barbara and 4-year-old son, Zachary.

One of the class heroes, **Jack Solomon**, has been promoted to a marketing job with Union Carbide in Harrison, N.Y. His responsibility is for applications of industrial gases in the steel, chemical, electronics, and other industries. The Solomons' oldest daughter, Sheri, is living in Santa Barbara, Calif., attending UCSB. Daughters Lisa, 6, and Susan Ruth, 3, are developing on schedule. Spouse Jan is very involved with the American Field Service exchange program, and the Solomons have had two AFS students during the last five years — a boy from Chile and a girl from Japan. Jack also reports that he saw **Marvin Singer** in Washington last spring. Marvin is with the Department of Energy and is involved with the synthetic fuels program.

The other class hero, **Dick Males**, is still in Cincinnati, still with Enviro-Engineers. His work is varied, involving such jobs as computer graphics for the city of Cincinnati, police data management systems, water supply system modeling, and studies of graphic communication techniques. Most of it is computer-related, and he enjoys it. Barbara runs a tutoring group for children with learning disabilities. Dick says that most of the stress in his low-stress life revolves around being the parent of a teenager. (Son Matthew turned 15 in February.) Nathaniel, 6, is in kindergarten. Dick is involved in a number of civic activities — committees, boards, and the like which take up much of his time. He has retired from karate — he got tired of being kicked around by young bodies that love to fight. His new love is the tenor sax, and he plays a mean medley of 30s and 40s tunes.

End of notes for the month. I enjoy getting a letter from you now and then, and the word must be getting around. Drop me a note with news of your doings. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

65

Because of more fund envelopes and a few real letters, this will be my first "decent" column. First, an announcement: **Dave Manalan** called in mid-December to say that the reunion books would be mailed in a day or two to everyone who had paid for one. If you haven't received yours by the time you read this or if you want to order one for $5.00, get in touch with Dave at 7 Kelley Rd., Acton, MA 01720.

Bill Stowell sends a nice long note about his spare time activities. The big news is that Bill completed the Espirit Yogurt 10-kilometer road race (I won't write it as a marathon) in Cincinnati. Bill Rodgers of Boston Marathon fame was also entered, and Bill says he scored a major coup in that his time was actually less than twice Rodgers'. Bill adds that he was also able to stand up, barely, at the conclusion of the event. Bill also encloses newspaper clips from the *New York Times* and *Cincinnati Enquirer* about his newly patented electronic shark repeller. Bill is with GE in Cincinnati but invented the shark repeller in his spare time, and was looking for a manufacturer at last report. Bill has also been working on a magnetic field device that he hopes will kill cancer cells. He is currently redesigning some equipment and placing it in a research environment. Bill's wife Bonnie is active in Women Helping Women, a Cincinnati organization that runs a round-the-clock women's crisis center.

Steve Rosenberg writes to say that he has left Ogden Security, Inc., which he helped to form in 1972 and has formed a new company, International Service Consultants, Ltd., with an associate from Ogden. Steve is president of the new company, which works in a variety of fields including security (consulting, protection, investigation), management consulting, operations research, and other service activities. Steve says it is exciting to make the transition from being an employee of a large corporation to being the leader of a small business.

Pierre Perrolle is now manager of U.S.-People's Republic of China programs for the National Science Foundation. He moved there in October from the National Academy of Sciences' (NAS) China Committee. He says the highlights of 1980 were negotiating an agreement between the NAS and the Chinese Academy of Sciences on cooperation in the basic sciences and visiting China for the third time since 1978, accompanying members of the National Academy of Engineering Council.

Jonathan Addelston is now the manager of systems software for the Office Information Systems products of Wang Laboratories. Jonathan reports that he has two daughters, Miriam (7) and Rachel (4). . . . **Kenneth Ross** is living in Palo Alto and has a 9-year-old son and 5-year-old twins. He is president of Ross Systems, Inc., a computer time-sharing and management consulting company. . . . **Dan Diamond** has been named director, corporate marketing, of Chomerics, Inc., a maker of keyboards and shielding materials.

William (Billy) Murphy has been elected to the Maryland Supreme Court. After graduating from M.I.T., he worked for Martin Aircraft for a couple of years, then went to the University of Maryland Law School where he made Law Review. He passed the bar and practiced criminal law until being elected to the Supreme Court last November. Billy is married and has four children. His father has been a judge in Baltimore for ten years. Billy's family owns the Afro-American newspapers of Baltimore, and Billy sat on the board of directors of the company for a year "between cases." Our congratulations to him.

Charles Seniawski has been promoted to lieutenant colonel in the Air Force. He is assigned to the 341 Strategic Missile Wing at Malmstrom AFB, Montana, and has served in several missile maintenance positions there. . . . **Christopher Ebbe** is the psychology intern coordinator for the San Bernadino County Department of Mental Health. He reports that he is enjoying backpacking in the Sierras.

Charles Deane is back in Glastonbury, Conn., after spending the summer of 1980 sailing on the North Atlantic along the Nova Scotia coast. . . . **John Chiappetta** participated in the October 1980 Alumni Fund telethon with 18 other Houston alumni. . . . **Greg Schaffer** is still rock climbing and in October placed eighth out of 50 in the Great Western Boulder Climbing Championship. He is also active with women's rights groups and is an officer of the local chapter of NOW.

That's more like it. Keep those cards and letters coming. — **Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66 15th Reunion

When you read this, it will be spring and *warm*, but as I write it is well below zero. It could be worse. — I could still be walking across "The Bridge" to class. We are looking forward to showing our girls "The Bridge" and other more historical sights in Cambridge during the reunion, June 4-7. Technology Day 1981 will be Friday, June 5, with this year's program focusing on the automobile. We hope to see lots of you there.

We have lots of news from California this month. **Roger Koch** writes that he is now employed by Rockwell International in Downey, where he is involved with space shuttle avionics. He spent the previous twelve years with JPL as a member of the navigation teams for interplanetary missions. . . . **Carson K. Eoyang** is an associate professor of management at the Naval Post Graduate School in Monterey. He and Kemay had their third child, Lian Shu, on August 23. . . . **Robert Fila** is currently project manager for the planned community of Bernardo Heights within the "new town" of Rancho Bernardo in San Diego County. The planning has been underway since 1978 with the first homes scheduled for sale this year. Over 22 million cubic yards of dirt are being moved for this project! He and his wife also have three children.

Robert Poole, Jr., is the editor of *Reason* magazine, headquartered in Santa Barbara. The magazine is a "forum for analysis and commentary, with an emphasis on individual liberty."

Dennis Overbye is also continuing in the journalism field as a staff writer on *Discover*, a science news magazine published by *Time*, Inc. . . . After six and one-half years on the southern tip of Africa, **Terry Vander Werff** and his family (which added three new members while there) are returning home to America. He writes, "We have seen a lot of changes during our time here — Angola, Nambia, Mozambique, and Rhodesia all have undergone profound political changes, as has South Africa itself. Our only regret is that we did not travel widely while here. But we've grown both personally and professionally, so we are eager to face our new lives back in the States." . . . Another traveler, **Dimitri Procos**, just returned from a vacation in Sifnos, Greece. He is the first chairman of the newly founded School of Urban and Rural Planning at the Technical University of Nova Scotia. He does energy related research on biomass waste fuel, municipal energy management, and energy planning in general.

It's much easier to do this column when there is lots to write about, so keep sending the news. — **Eleanore Gieron Klepser**, Secretary, 317 Broad St., Port Allegany, PA 16743

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I'm proud (and tickled blue) to announce the arrival of our second boy, Thomas James, born December 14. . . . **Bob Howard** and Sharon Silver honeymooned in the Bahamas following their wedding October 19. Ruth and **Neil Steinmetz**, **Lou Offen** and **Eric Coe** attended the wedding. Sharon has her own family counseling business. . . . **Bruce Jacobs**, assistant professor of political science at the University of Rochester, has received an award from the American Political Science Association for the best doctoral dissertation of 1978 or 1979 in the field of intergovernmental relations in the United States. Bruce is on leave for 1980-81 to assist in and study the development of home equity conversion programs for the elderly. He co-authored the book, *Old Folks at Home*, which was published last year. . . . **Alan Saleski** was recently appointed dean for the natural sciences at Loyola University of Chicago. He was an assistant professor at the University of Illinois for five years before going to Loyola in 1976. He received his M.S. and Ph.D. from Berkeley in 1971. . . . **Dan Drucker** has been promoted to associate professor of mathematics at Wayne State University. He lives with his wife Sue and their two children in Southfield, Mich. . . . **David Irwin** is in Potsdam, N.Y., pursuing an interest in computational physics while looking for a job and studying in a graduate program at Clarkson College of Technology. . . . **Andrew Lemer** is a member of the international division of PRC Planning and Economics with responsibility for business development in a number of countries. He commutes to Lagos, where he directs a study of cost recovery strategies for irrigation projects. . . . **Bill Christiansen** was recently blessed with his fourth (and last) child, Kinsey Anne, born October 7, 1980. That makes a matched set of two girls and two boys. Bill is executive vice-president of Equipment Co. of America, a manufacturer of materials handling equipment. . . . **Roy Gamse** is still with the EPA in Washington. He made it to a Rose Garden awards ceremony with the president, having been selected as one of the first 49 distinguished senior executives under a new federal bonus system. . . . In January **John Poucher** left academic life at Cornell and joined Bell Labs in Holmdel, N.J. He received his Ph.D. in physics in 1971. . . . **Jim**

Swanson, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

69

I went to Florida for Christmas, to find -4° F temperature at the airport when I returned to Boston. So far January is 13° F below "normal" and the coldest on record.

Gus Kayafas has started Palm Press, Inc., in Concord, Mass., which is producing and marketing photographic slide sets, books, and portfolios. He produced Doc Edgerton's portfolio of photographs which has been shown in a number of galleries in the U.S. and abroad.

Paul Beckerman has been doing a lot of traveling since graduation: 1969-72, with the Peace Corps in Bolivia; 1973-76, at Princeton for course work towards his Ph.D. in economics; 1976-77, thesis work in Brazil; 1977-79, assistant professor at the University of Illinois; and 1979-80, Boston University. Paul is currently in Lima, Peru, on a Fulbright grant, teaching and carrying out research at the Catholic University of Peru and at the Central Reserve Bank.

California has seduced a few classmates (and with this weather I'm tempted!). **John R. Smith** is now technical director for the Undersea Warfare Program Office at Hughes Aircraft in Fullerton, while he lives in San Clemente. . . . Giving up his professorship, **Frank Quick** is now working for Burroughs Corp. in San Diego. . . . **Monib Khademi** is an EST trainer candidate in San Francisco. . . . **Stephen Lee**, who has a 2-year-old daughter and a new eight pound, nine ounce son, has been promoted to vice-president, Western Region, in charge of the Santa Clara office of Energy Management Associates, Inc., whom he joined only a year ago.

W. David Lee is manager of the Thermal Energy Technology Unit at Arthur D. Little, where he has been for nearly ten years. David has been maintaining a chess game by mail with **Smith (Tom) Wood** in Washington, D.C. Tom thinks he's winning and is still rowing with **Rodger Doxsey** who is at the M.I.T. Space Center.

Still in the Air Force is Major **Dave Herrelko**, who is executive officer for Air Force Systems Command's deputy chief of staff/plans at

Michael J. Underhill has moved from Toronto to Houston to start his own architectural practice and to join the faculty of Rice University School of Architecture as an assistant professor.

Center in Sudbury is **Tom Schonhoff**, who received his Ph.D. in electrical engineering from Northeastern last March.

Still in the Air Force is Major **Dave Herrelko**, who is executive officer for Air Force Systems Command's deputy chief of staff/plans at Andrews Air Force Base, Md. According to pictures in an article in *AFSC News Review*, Dave's appearance has not changed in 11 years except for the acquisition of his wife Jan and daughters Kathy (5) and Emily (3). He got his Ph.D. at UCLA in 1976 and is heavily involved with computer architecture for weapons systems.

For the last seven years **Ken Horner** has been involved with management consulting at Touche Ross and Co. where he is now a partner in their New York City office. Ken lives in northern New Jersey with his wife Barbara and their 2-year-old daughter Cecily Kate.

Michael J. Underhill has moved from Toronto to Houston to start his own architectural practice and to join the faculty of Rice University, School of Architecture, as an assistant professor.

Finally, if you're a technically trained physician and think you might like to live in Boulder, Co., get in touch with **James Kornberg**. A year ago he established COHBI Corp. (Comprehensive Occupational Health for Business and Industry) which services over 35 new energy technology industries (oil, shale, coal, solar) as well as other more conventional businesses. James serves as consulting medical director for 14 companies, and with only three other staff members, they are looking for another.

A lot of information this month. I'm off on a trip in a couple of weeks, and I'll tell you about it next month. — **Robert K. Wiener**, Secretary, Box 27, M.I.T. Branch, Cambridge, MA 02139

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Richard Millar, Jr., has recently been appointed director of materials for Burndy Corp. He was formerly with Leviton and will relocate with his family to Stamford. . . . **Louis Edelson** has commenced his internal medicine practice in San Francisco where his spouse practices in a San Francisco law firm. . . . **Howard Radin** normally provides software packages to international commercial banks and develops data base systems for microprocessors but was sidetracked with work this last year on computer fraud litigation against a major hardware manufacturer. . . . Change has come to **John Kessinger** and family. He moved to Philadelphia and assumed a position with Westinghouse Electronic's Steam Turbine Generator Division as domestic sales manager while becoming a father of twins. . . . **David W. Kurtz** will join the staff of the radiology department at N.I.H. after he completes his two-year tour of duty with the U.S. Army as a radiologist in Heidelberg. . . . **David McIlwain** worked in one of the largest regional political field offices of a U.S. Senatorial candidate in New Hampshire. . . . **Tim Gilmore** plans to start his residency in Seattle after finishing medical school at the University of Washington. . . . **Richard T. Ku** received his doctorate in electrical engineering recently. He worked formerly for Intermetics and TASC before becoming a consultant in electronics applications in the Technology Management Services at Booz Allen. . . . **Edward Sayer** received his Ph.D. in psychology and plans to work for Matthew Horton Health Plan in Nashua. — **Robert O. Vegeler**, Secretary, Kennerk, Dumas, Burke and Backs, 2120 Ft. Wayne National Bank Bldg., Ft. Wayne, IN 46802

71 10th Reunion

Ten year reunion. Your classmates have great plans for our 10th. Accomodations are available at a reasonable price and the entertainment will be terrific. All of you should have received a mailing by now about the reunion, but, if not, please contact the Alumni Association at M.I.T. Nineteen classmates have already signed up to attend: **Ned Sauthoff**, **William Haggerty**, **Robert Dresser**, **William Birthisel**, **Richard Kurzel**, **Paul Lewis**, **Mitchell Serota**, **Denis Loring**, **Martin Jack, Jr.**, **Alexandra Zakak**, **Robert Terwilliger**, **Matthew Becker**, **John Halperin**, **Peter Lindner**, **Daniel Griffin**, **Philip Smith**, **Riva Poor**, **Michael Richter**, **Kerry Mull**.

Leonard Tower is in software engineering working for a small computer consulting firm on special purpose language design and word processing systems. . . . **Laura Middleton** has left the wilds of Arkansas to practice at Health Associates of Provincetown, Mass., a public health care facility. . . . **Katherine Futornick** writes: "For the past ten years, Ken and I have lived on a small piece of acreage in Oregon. Ken is an electrical engineer at Tektronix while I continue my interest in land use policy and architecture on a part-time basis. By this time next year I will have completed a master of science degree at Oregon State University and have begun a Ph.D. program. For those who remember Artemis, the resident beagle of McCormick Hall (1969-71), he is romping through the Oregon woodland at 15 years of age."

Avi Ornstein writes: "I'm still teaching high school chemistry . . . but now teaching at Berlin High School in Berlin, Conn. In addition, my family recently expanded, so Satya is not alone. Bernke bore twins: Joshua and Alia on October 15, who set a new record for total weight of naturally born twins at the University of Connecticut Health Center. All are doing well." Our congratulations to Avi and Bernke for a double blessing. . . . **L. Scott Ramos** writes: "Joan, Lia, and I are back in Brazil, this time in Manans, the capital city of the Amazon state. I have a job with the National Institute for Research on Amazonia where I'll be running a new Finnigan 4000 gas chromotograph/mass spectrometer/data system for natural products research." . . . **Robert L. Justice** is currently a second-year fellow in medical oncology at the Cancer Center of Hawaii.

Mark Buntzman is making news as a film producer. His new picture, *The Exterminator*, received a long write-up in the White Plains, N.Y., *Reporter Dispatch*. Mark, as you remember, produced a science fiction flick, *The Astrologer*. He then researched what kind of movie would sell on domestic and foreign markets and made one. The content? Action and violence with a pretty leading lady, Samantha Eggar.

Please come to the reunion. If we get some rain in Texas and the economy doesn't self-destruct, I hope to make the trip. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

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Andy Mermell writes, "This is the first time I've checked in with *Tech Review*. After finishing a number of incompletes and taking some additional classes, I both graduated and attended our 5th Reunion in June 1977. I'm a software engineer at Distribution Management Systems in Bedford and am thoroughly enjoying the work. I'm married to Edith Aronson of Malden. We're living in Newtonville and celebrated our first anniversary in November."

Steven Goldstein writes, "My wife Shelley and I are still living in Cincinnati where I am a patent counsel for Proctor and Gamble. Our two-year-old daughter Rebecca is a joy. We also have a cocker spaniel; she is also a joy — generally. We all spent last year in Brussels. The work was interesting and the traveling fantastic."

David Morgenlender is a group manager for the Saddlebrook Corp. in Cambridge. . . . Dorothy and **Lawrence Baker** had their first child, Elizabeth Eve, July 25, 1980. . . . **Paul Hochfield** is an E.R. physician in Corvallis, Oregon, soon to be moving to the Coast Range, "miles from anywhere except a real community." . . . **Stephen Glazier** reports he is practicing law, issuing private real extate syndications, and helping wealthy foreigners make U.S. investments. . . . **Sally Simon** is president of the Boston chapter of the Society of Woman Engineers. . . . **Richard Weissberg** is in the master's program at Sloan.

Lawrence Bacow has a book published by the M.I.T. Press entitled, *Bargaining for Job Safety and Health*. He is an assistant professor in Urban Studies at M.I.T. . . . **Chip Kimball** is building a new house in Newton. . . . Maintaining a class tradition, **Bonny Kellerman** is taking **Joe Edwards'** place as director of the Educational Council, so don't be surprised if even more of you get asked to do some interviewing of M.I.T. applicants.

Michael Sims writes, "I was possibly the only New Jersey resident to be accepted by Einstein Medical and turned down by Rutgers. I graduated in 1976, interned at Los Angeles County, and did an emergency residency at Christ Hospital (Northwestern University). I did one year as officer in charge of E.R. at Cott AFB, recently demoted to staff M.D. I married Jeanine DeCoster (Wellesley '76)."

I received a long and interesting article from the Brunswick, Maine, *Times Record* on **Rod Regier** and his wife, Shirley Matthews. He is now working full time making harpsichords, and she is a music teacher and harpsichord soloist. They are living in Freeport. — **Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

73

The gang may not all be here, but a few of the faithful have dropped lines to keep their class-

mates up on their "doings." **Debra Judelson**, the fair M.D., is finishing a cardiology fellowship in L.A. and ("finally") entering the job market in July. . . . Oilier this week, **Dean North** wrote that he was still living and finding a little oil.

Richard Goettke, after finishing a clerkship with a Cincinnati judge, has been practicing law in a small village in Southwest Ohio. He has recently obtained his private pilot's license and spends a lot of time in a Piper Warrior 161. . . . **William Blum** has been living in the Virgin Islands for two and one-half years as legal counsel to the V.I. Commerce Department. He was just appointed to be the governor's counsel, serving the Honorable Juan Luis. Bill, too, has been seeking a pilot's license to improve island hopping. . . . **Stephen Jovanovich** is working on a doctorate in microbiology at Davis, California. . . . **Drew Gillett** has twins.

Doug Luther Ph.D.ed in oceanography from M.I.T. last February and is now ensconced at the Scripps Institute in San Diego, studying waves (some from first-hand look from a board). Visitors, weather permitting, are welcome.

From '73 midwest comes no news of **Tony Scandora**, presumably resulting from months of post-marital seclusion. And, I regret to say, the same is true here. Except for a change of location, naught looms. Au reservoir. — **Robert M. O. Sutton**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

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Cambridge, January 12, 1981. Temperature 6 degrees Farenheit (minus 14 Celsius). Crunchy frozen snow on the streets and sidewalks. I think you are lucky to be in April already.

Having completed a master's degree in math at the University of Minnesota, **Daniel Kersten** is now a graduate student in the Psychology Department there; he is doing research in visual psychophysics and physiological optics.

Andrea Sue Reyman lives in New Orleans and is a production engineer for Shell Oil Co. She finds that the most fun part of her job is riding to and from the offshore oil rigs she supervises in a helicopter. Previously, she spent some time working as a mountaineering instructor for the National Outdoor Leadership School in Wyoming. That sounds like fun too! . . . **Arthur Apter** writes, "I'm in my second year as an assistant professor of mathematics at the University of Miami. I've found it difficult to adjust to life in Miami, but I've gradually been doing so." Other M.I.T. graduates in the department include Bernie Howard, '43, Ken Holladay, '72, and **Wensor Ling** who recently received his Ph.D. in math from Princeton, according to Arthur.

Bruce Davidson is director of clinical services at a small outpatient clinic in east Los Angeles, where he is rapidly "learning the ways of the bureaucrat/administrator." Bruce says he is looking forward to going back to graduate school in another year or so. . . . "I am enjoying being a student again," writes **Barry Weinstein**, who has entered the M.B.A. program at Baruch College (CUNY, New York). Barry is also involved with NYC M.I.T. Young Alumni and is an Educational Counselor.

Finally the medical department. **Greg Rothman** is a resident at Lenox Hill Hospital in New York. "Residency is not a piece of cake, but is light years better than internship," he says. He is applying for a fellowship in endocrinology in New York City. . . . **Edward Capparelli** is a second-year resident in family practice in McAllen, Tex., where his wife Gillian is a staff nurse for a pediatric group. "We greatly enjoy living in south Texas," he adds. . . . **Ralph Martin** is a resident at St. Vincent Hospital in Worcester (wooh-stuh), Mass. . . . **David Dinhofer** is an intern in internal medicine at Maimonides Medical Center in Brooklyn, N.Y. Over and out. — **Alex Castaldo**, Secretary, 929 Massachusetts Ave. (12D), Cambridge, MA 02139

76 5th Reunion

In person: Your secretary had the pleasure of attending New Year's at **Erland van Lidth de Jeude**'s. Erland is a smash in *Stir Crazy*, a movie, according to *Variety*, that has "good legs" (staying power at the box office). As a result of this movie, he will be heading to Sri Lanka in February to play in a new "Tarzan" film opposite Bo Derek. He is looking forward to it! Also, at his party, your secretary had the pleasure of seeing **Margaret Hainsworth**. Margaret has received a promotion at IBM. With her rate of progress your secretary is glad he doesn't have to compete!

The mails: From **Jeffrey Grossman**, "The Army did the unthinkable, so I am at Camp Stanley, near Uijongbu, Korea. I'm assigned to the 2nd Battalion 61st Air Defense Artillery (2nd Infantry Division) as the communications-electronics staff officer. It's certainly an experience being in a place where when the alert siren goes off we don't know if it is real or practice."

Sheri Abrams reports, "Michael and I got married at Temple Kehillath Israel in Brooklyn last May. Lovely wedding . . . still slugging away at a Ph.D. at the University of Illinois. I may graduate some year, who knows?" . . . **Peter Galitzine** writes, "Still with Autech building hydraulic/electronic test equipment and writing some technical articles I'm inordinately proud of. Motorcycle racing is temporarily shelved (too much crashing and burning) for some serious hunting instead. Being helped in the latter by a 3-month-old springer spaniel bitch named Suze. Great fun — recommend to everyone."

F. S. Tsuchiya is working for MTS Systems Corp. as the manager, mechanical systems engineering, Vehicle Dynamics Division, designing test systems for autos, railcars, and aircraft. He is also a member of the M.I.T. Minnesota Education Council. . . . Kim and **Jim Ryan** send word of the birth of their son, Scott, on September 1, 1980 (Class of '98?).

Jim Wajda has taken a position as a systems analyst in telecommunications at Illinois Bell Telephone. He is still working with teleprocessing and networking software. . . . **Jeslie Chermak** succinctly states, "Looking forward to 5th Reunion." . . . And from **Peter Hagelstein**, "Although it is hard to believe, it appears as if I have finally finished with M.I.T. — at least as far as being a student. I am trying to finish up my part of the X-ray laser work and am looking forward to a change. Still single but trying to correct that."

Jay Gurley is still at Motorola in Fort Worth developing processor-related mobile communications equipment. "In my spare time I tinker at 'Ferrari of Texas' restoring pre-1968 exotic sports cars, including Maseratis and such. We are in the process of moving to larger indoor quarters, at which time we will get back to work. We already have a large backlog of cars. For a car freak, it's heaven!"

Steve Spura has been working on the development of an energy conserving light bulb for DuroTest Corp. in New Jersey. He married Margaret Cushing from Hingham, Mass., in August, 1978, and they're expecting their first child some time in January 1981. Our congrats! He also sends news that **Lee Gearhart** got married in June 1980 to Joanne Skelly in Rochester, N.Y., where he is employed by the Gleason Works. . . . **Jim Banks** is "working for Hewlett Packard in the heart of Silicon Valley designing the electronic instruments of the future. Last August I married Thelma Williams. **Kevin Campbell** was my best man."

And from the commodity pits: Your secretary has been promoted to vice-president of trading and research. From what he has been able to gather, he is the youngest in this type of job on Wall Street! Since the last notes, we have had a wild time in heating oil (up), grains (up and down and up), interest rates and lots of Swiss francs. I regretfully report that I dilly dallied and failed to buy frozen orange juice concentrate. Wouldn't

you know it, there has been a freeze! I continue to look for a year of pleasant (!) economic and political disasters. I look forward to seeing many of you at our 5th Reunion this June. I will be attending even if I have to trade via mobilephone. And I hope many of you will also take the time to attend. Imagine, five years! — **Arthur J. Carp**, Secretary, Sandro Rohstoff, Inc., 1 World Trade Center, Suite 9853, New York, NY 10048

77

Carol Catalano received this note from **Doug Abramson** and forwarded it to me: "I'm writing to inform you that I have moved once again. This time it will be for several years, as I have purchased a condominium. I have been enjoying California since I moved in December 1979 and have also enjoyed visits from several fellow Fiji Brothers: Bill Rizzi, '76, who lives in Venice, Calif., and I have been visited by Ramon Vallejo, '75, and his wife, Bruce Nemlich, '78, and also Jim Cherry, '78. I'm working for RBF and Associates which is a civil engineering consulting firm in Newport Beach. We are a top-notch company of 130 employees. I am working mainly in hydrology, hydraulics, and flood control. All of which are badly needed here in southern California. (When it rains, it pours.) I have plans to be married this upcoming May to Maria Kulick, who graduated from Northwestern University. We met in graduate school at the University of Washington where we both received our master's degrees. The wedding will be here in Laguna Beach on May 2, 1981."

David Doo, who lived on Connor 3, married Alpha Pon in May 1980. Many M.I.T. alumni attended the wedding. David and Alpha both work for Hughes and live in Anaheim, Calif. . . . **Ronald Watro** is writing a doctoral dissertation on choiceless combinatorial set theory at the State University of New York in Buffalo. . . . **George Goodman** is a control system engineer at General Electric in Pittsfield, Mass. . . . **Steve Keith** writes, "Since last year I have been aboard the nuclear-powered aircraft carrier *U.S.S. Enterprise* while she undergoes overhaul at the Puget Sound Naval Shipyard not far from Seattle. It's beautiful country, but the grey weather takes some getting used to. The ship should be returning to her home port of Alameda, Calif., next summer." . . . **Danny Bigio** is doing computer software and peripherals for industrial applications and administration of automatic process control. Also, he is in an advisory capacity in sales production forecasting, and computer simulation, special projects, and mini-transportation side cars.

"Still working on my Ph.D. in chemistry which should be complete by the end of 1981," writes **Randy Perez**. . . . A note from **Greg Coutts**, "I am still running a small biomedical engineering service company here in Toronto. We have expanded rapidly and now service 23 hospitals and employ 10 people. I am continuing my M.B.A. studies part time; it is long and slow. Had a great

summer, went to Tim Dove's ('79) wedding in Dallas and saw lots of alumni. I am looking forward to a good winter."

Tom Gooch moved to Fort Worth and is taking up residence there. he is working for Freese and Nichols Consulting Engineers. . . . **Richard Maebius** obtained his master's degree in nuclear engineering from Carnegie-Mellon University in 1978. He left the nuclear business last spring and is presently working as a research engineer for PPG Industries in Pittsburgh. He is also a member of the Educational Council there and looks forward to seeing anyone who happens to wander through. . . . **Peter Cunningham** writes, "I've been married since August 1978 to Janet Freeman, '78. We live in our home state of Washington in Tacoma with both of our extended families within 50 miles. We bought a house last July at 11.25 percent. We were tired of watching the government take so much of our paychecks! We both work for her family's manufacturing firm as its engineering/R&D department. I worked with the company president to design and develop an interface between Loran-C Navigation Computers and our Marine Automatic Pilot. The two of us now share a patent on it. We're still doing R&D but now are also learning management. I sometimes go to trade shows in Miami and Boston as a company rep too."

Tom Heggestand worked with the successful Taproch movement, sponsoring an anti-nuclear proliferation referendum which was approved by voters in several areas. More next time.— **Doug McLeod**, Secretary, 1641 Smith St., Green Bay, Wisconson 54302

78

In response to my impassioned plea for contributions to my boring postcard collection, **Evan Klein** sent one of the Harbor-Santa Monica Freeway interchange in Los Angeles. Evan is living in Santa Monica and is in his first year at U.C.L.A.'s M.B.A. program — and loving it.

Don Lapin sent a "banal postcard" of the Capitol Building in D.C., which he visited en route to his annual R/O week visit to Boston. Don is a process development engineer at OXIRANE (ARCO) in Houston and in his spare time is an Educational Counselor for M.I.T. at two high schools in Baytown, Tex. Don writes that he sees **Pete Stasekelis** regularly; Pete works for Dresser (Drilling Tools Division) but is thinking of going back to school to get his Ph.D. in biology.

Mike Harlan's contribution to my collection was "a somewhat nondescript hotel by a highly notable river," namely the Nile Hilton. Mike seems to have spent a lot of time around the Mediterranean — including Athens, Palma de Mallorca, and the pyramids. But mostly, he spends his time *on* the Mediterranean; he's stationed on the *U.S.S. John F. Kennedy*, working in a fighter squadron.

Kathy Hardis sent a postcard that contained three breathtaking water color paintings of Delta Airlines Jets. (It's so boring that I might even have it laminated.) Kathy is working as a staff scientist for a consulting firm in Washington, D.C.'s Georgetown district doing work in the toxic effects of chemicals. Kathy's big news is the recent announcement of her engagement to Marty Fraeman (M.I.T. Class of, approximately, '74) — the date is late in March.

Carrick Davidson must have decided that the most boring picture postcard was one with no picture. (Somehow, I don't think that it's in the spirit of my collection, though.) Carrick grad ated in September 1980 with his master's in techology and policy from M.I.T. and has started working for Trinity Consultants, in Dallas — an air pollution consulting firm. he writes that he'd like to hear from other M.I.T. alums in the Dallas area. (Those are all the postcards that I have received thus far. Keep trying folks — surely there must be a nice airport or shopping center nearby.)

While waiting in line at a recent University of Michigan blood drive I suffered a severe *deja vu* —just like at M.I.T., there he was, running from station to station, there was someone who looked just like **Vinay Reddy**. In fact, Vinay, who had been responsible for so many of M.I.T.'s blood drives, has moved to Michigan and has started organizing blood drives at the U. of M. In his spare time, Vinay is working on his master's in biomedical engineering here at U. Mich.

Paul Lagace writes from the midst (mist?) of his — gasp — seventh year at the 'Tute, where he is getting closer to his Ph.D. in aero/astro. Highlights of the past year include: presentation of a paper at a composite materials conference in Paris, being a member of M.I.T. President Paul Gray's inaugural procession, and being the pitcher on last summer's champion fast-pitch team in the M.I.T. Community Summer Softball League. . . . **Diane Riker** is at Stanford working on her M.S. in mechanical engineering and doing research in pressure sore instrumentation. Diane is engaged to be married to fellow alum Jim Hutchinson this coming June. . . . **Albert Frazier** graduated from Harvard Business School last year and is now working for Booz-Allen and Hamilton, a management consulting firm. He's based in Cleveland, but the job brings him traveling around the country extensively. . . . **Kathy Lyon** is currently at Harvard's B School as a first year student, along with her Course II classmates — **Yousef Javadi**, **Jeff Kohler**, **Gene Hall** and **Kelly Pan**.

The *Salem* (N.H.) *Observer* recently contained a brief article about one of our classmates, reporting that **Dan Fischbach** (married to the former Kathryn Flanagan) is a lieutenant assigned to the frigate *U.S.S. Kirk*, which was recently deployed to the Indian Ocean. (Unfortunately, the article was entitled, "Fischbach in Indian Ocean" — I leave this to the imagination of the punsters amongst us.)

As I move into my last semester as a law student, looking forward to a very heavy workload and a difficult job search, (I'm very picky), I begin to wonder if I really *do* want to be a lawyer. And then I remember that I got senior-itis my last term at M.I.T. too, and, in a near-disastrous fit, almost changed departments. Hopefully the latest throes of senioritis will pass by the time you all read this, and I'll be preparing to move to Boston or to Washington, D.C., to start my job in June. But just in case, send me a boring postcard for my collection — it'll make my day. Wishing you all a warm and happy spring, this is **David S. Browne**, Secretary/Treasurer, 315 N. Thayer, No. 7, Ann Arbor, MI 48104, (313) 997-9565

79

As I write this, I am struggling through one of the coldest winters in my memory! Hopefully the spring has come to us all by now. Why didn't I go to Stanford B-School instead . . .

Speaking of business school, **Dave Soule** is in his second year of New York Univerity's M.B.A. program, majoring in business economics. "School is not bad, but the commute in and out of New Jersey is a pain!" Dave adds, "I did not expect to be writing a thesis quite so soon." (I can relate to that statement!) . . . **Ted Anderson** is having a good time in California, where he has been working at the Lawrence Livermore Lab since graduation. Ted is designing and writng an operating system for the S-1 computer currently under development there. . . . **Mary Jeanne Packer** spent six months with the phone company in Boston. Now plying her with civil engineering trade in Vermont, she is locating, designing, and constructing roads for the Green Mountain National Forest.

Mitchell Weiss, formerly with Unimation in Danbury, Conn., moved down to Pennsylvaia last year. "Have spent the last seven months designing and debugging an indusrial robot for light manufacturing. Got back this week from the annual robot show in Detroit where we introduced it, along with our company, United States Robots, Inc., where I am chief engineer. It went well, and we received over 2,500 inquiries on our new product — all very exciting!" . . . Our man in uniform, **Gerald T. Michael**, attended the Transportation Officer Basic Course in Ft. Eustic, Vir., after graduation. He is now assigned as a platoon leader in the 396th Transportation Co., located at Ludwigsburn, FRG. . . . Also in the army are **Dan** and **Cathy Jaime**, who recently brought home a little sister for 3-year-old Maria and 2-year-old David. Juanita Margarita made her appearnce on October 26. . . . Speaking of babies, **Dwight L. Davis** reported back in November, "We're expecting our first child any day now." Dwight describes his home — Pleasant Valley, Tenn. — as the "naval archiecture capitol of Tennessee, population approximately 300, two naval architects — my boss and me!"

Claude von Roesgen writes that he is an independent filmmaker and requests that you send him any ideas you have. Last summer, Claude and **Jimi Parks** set out to walk across the country. "We made it from the No. 6 Club to Waynesboro, Vir. We spent 80 days on the Appalachian trail." Claude also reports that **Earl Lipson** has bought a silk screening franchise called "Trend Sensors." He hopes to expand its influence until he can call it "Trend Setters"! His debut product will be a "Don't Blame Me, I Didn't Vote" tee shirt!

That's all for now (what could one possibly say after that?!). Write soon. — **Sharon Lowenheim**, Secretary, 3600 Chestnut St., Box 1166, Philadelphia, PA 19104

80

And now for a word from the West Coast correspondent. As I do get something in the mailbox now and then besides bills, **Kenneth Turkewitz** has asked me to write a column every third issue. So, feel free to drop me a line. As we go to press, Ken is finishing up his bachelor's thesis.

Jim Boots has joined the Chevron Chemical sales force in San Francisco. Jim will be out peddling chemicals in a few months when he completes his training program. . . . I ran into **Hong-Kien Ong** the other day. He is in S.F. working for Wells Fargo (the bank, not the stagecoach line). . . . Recently up from L.A. and on location is **Scot Brennan**, who has joined Bechtel.

Jean Singer, '79, and I tacked a weekend in L.A. onto the end of business trip to San Antonio. There are several class members in the area. Among them is **Denise Martini**, now at Tishman Construction Co. . . . I coerced **Mike Johnson** into rounding up some '80 types to visit over a few beers — like all good alums. Mike is working for the Air Research Division of the Garrett Corp., as is **Bob Melvin**. Fellow Beta **Steve Alexander** is with TRW. Also along were **Tom** and **Gerry** (**Colten** and **Hammond**), who are sharing an apartment. Gerry is working for Southern Cal Edison, and recently bought a diesel Rabbit. Tom says he's been working on the railroad — the Atchison, Topeka and the Santa Fe.

A few classmates have — uh — tied the knot since graduation: **Tom Cosgrove**, **Doug Ward**, **Bob Edelberg**, and **John Molitoris**. Congratulations, guys! . . . **Steve Pettinato** is rumored to be paddling around with the water polo club while at the University of Chicago School of Business. . . . Also there is **Susan Rose**, who writes that the social life is great and she's dating an engineer (what else?). . . . Yet another soul at M.I.T. for grad school is **Mark Alexandridis** with the Department of Civil Engineering. . . . **Chris DeMarco** is doing his time at Berkeley, while **Terry Neiman** is at U.C.L.A.

As for me, I've just interviewed my tenth prospective student for the 'Tute — they broke the mold when they admitted us. In keeping with my job, I've recently joined S.A.E. (that's the Society of Automotive Engineers). Well, gang, that's about it. Not exactly the Rona Barrette of the Class of '80, but I'll keep writing if you will. So long for now. — **Debbe Utko**, Assistant Secretary, 1730 Sacramento St. No. 8, San Francisco, CA

M.I.T. INSIGNIA

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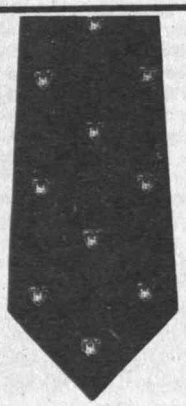

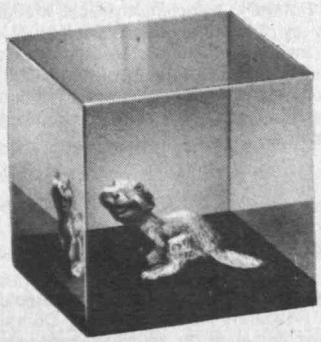

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Courses

I
Civil Engineering

Alan Katz, S.M.'75, has recently finished a judicial clerkship with a member of the Louisiana Supreme Court and has entered into private law practice with the firm of Gordon, Arata and McCollam, New Orleans, La., specializing in oil and gas law. . . . **Rogert Arndt,** S.M.'62, is a professor and director of the Saint Anthony Falls Hydraulics Laboratory at the University of Minnesota. He spent three weeks last year lecturing in China on hydraulic engineering and is active in aeroacoustic and cavitation research. . . . **Edward R. Holley,** Sc.D.'65, a professor at the University of Texas, Austin, won the 1980 Karl Emil Hilgard Hydraulic Prize of the American Society of Civil Engineers as co-author of a research paper, "Temporal Moments for Longitudinal Dispersion." **Albert G.H. Dietz,** Sc.D.'32, a member of the faculty, has been made an honorary member of the American Society of Civil Engineers. All of his professional life has been spent as a faculty member at the Institute and for the past ten years he has been professor of building engineering in the Department of Architecture, where is now professor emeritus. . . . **Francis S. Lynch,** Sc.D.'68, has joined the General Electric Research and Development Center, Schenectady, N.Y., as manager of Industrial Information Systems.

II
Mechanical Engineering

Professor **David Gordon Wilson** is one of the four authors of *Health Effects of Fossil Fuel Burning: Assessment and Mitigation* (Cambridge: Ballinger Publishing Co., 1981, $30). The report was released under the auspices of the Energy and Environmental Policy Center in Harvard's Kennedy School of Government, of which Professor Richard Wilson, senior author of the book, was director from 1975 to 1978. The major conclusion is that 50,000 deaths per year in the U.S. may be attributable to air pollution; thus there is very little "margin for safety" for increased coal combustion. Professor David Gordon Wilson's special contribution is a recommended program to tax pollutant emissions in proportion to integrated population exposures, with taxes to be rebated to affected communities.

Sheldon D. Goldstein, S.M.'73, has been named engineering manager for the Russellstoll Division of the Midland-Ross Corp., Livingston, N.J., manufacturers of electrical products. . . . **Douglas G. Bannerman,** Ph.D.'47, a retired research executive at DuPont, is currently doing volunteer work for the International Executive Service Corps; a 1978 project was interlining research at Dong Lim Textile in Korea. . . . **Norbert J. Denil,** Sc.D.'69, is presently a senior analyst in application development for IBM, General Systems Division, Atlanta, Ga., engaged in developing programming tools to be used in producing application products.

III
Materials Science and Engineering

C Sheldon Roberts, Sc.D.'49, is presently a consultant on materials and processes in San Jose, Calif., working both with large and small companies in the aerospace electronic materials, metals, instrument and mircroelectronic industries on their scientific and engineering problems and programs.

William B. Eisen, Ph.D.'68, has been named vice-president and general manager of Colt Industries Crucible Compaction Metals Operation, Oakdale, Penn. . . . **Deborah D.L. Chung,** PH.D.'77, assistant professor of metallurgy and materials science and of electrical engineering at Carnegie-Mellon University, has been awarded the 1980 Robert Lansing Hardy Gold Medal in metallurgy by the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers. She is involved at CMU in research on graphite intercalculation compounds, coal, composite materials, integrated circuits, and semiconductors.

V
Chemistry

John Schroeder, Ph.D.'72, is currently director of Aerodyne Research Inc.'s Center for Computer Applications, focusing on program management in the areas of electro-optical data analysis, pattern recognition and advanced sensor modeling

Draper to the Hall of Fame

In eight years since its establishment, only 38 inventors have been named to the National Inventors Hall of Fame. One of them, inducted this year as the second member of the M.I.T. community to be so honored, is **Charles Stark Draper**, '26, Institute professor emeritus who gave his name to a world-famous laboratory for inertial guidance and automatic control systems in Cambridge.

Election to the Hall of Fame is limited to innovators whose inventions have "demonstrated importance in terms of effects on public welfare and consequent advancement of the useful arts." In addition to Professor Draper, the Hall of Fame's 1981 initiates included Harold S. Black, a retired telephone engineer who invented a negative feedback to remove distortion in telephones; the late Chester F. Carlson, whose patent on "electrophotography" led to modern office copiers; and the late Nicolaus August Otto, inventor of the four-cycle internal combustion engine. Jay W. Forrester, S.M.'45, Germeshausen Professor in the Sloan School of Management, was inducted as M.I.T.'s first member in 1979 for his invention of magnetic core computer memories.

Reagan's Man on Domestic Affairs

Martin C. Anderson, Ph.D.'62, was in the first class of doctorate candidates to enter the Sloan School of Management in 1960; he received his degree two years later, a year before any of his classmates, and then went on to the faculty at Columbia University.

By 1968 Dr. Anderson had become director of research for President Richard M. Nixon's presidential campaign. Then he joined the Hoover Institution on War, Revolution, and Peace on the Stanford campus; and now he is assistant for policy development, the top advising post for domestic affairs in the Reagan White House. Dr. Anderson's M.I.T. thesis was a financial and economic analysis of the federal urban renewal Program.

design. . . . **S. Donald Stookey,** Ph.D.'40, has been awarded the Founders' Medal by his alma mater, Coe College, the highest award the college bestows on persons of national or international acclaim. Among his accomplishments: he has been awarded 60 patents while associated with Corning Glass Works where he was director of fundamental chemical research, of the firm, named inventor of the year in 1970 by George Washington University, holder of the Achievement Award of the Industrial Research Institute, the Franklin Institute's Award (1953 and 1960), the Purdy Award of the American Ceramics Society, the Myers Achievement Award in opthalmalic optics, and the glass industry's Phoenix Award. . . . **Kirk V. Darragh,** Ph.D.'68, a supervisor with Stauffer Chemical Co., Dobbs Ferry, N.Y. for 12 years, was killed in an automobile collision in Elmsford, N.Y., on November 21, 1980.

VI-A Program

It is with a great deal of pleasure that VI-A welcomes the addition of Tektronix, Inc. to the program. They will be having their first students this coming summer. **Richard D. Thornton,** '54 and Director Tucker visited their facilities in the Portland, Ore., area in mid-November. This completed negotiations begun some four years ago and will be the only company added to the program this year. Prime organizers in completing the negotiations were Thomas H. Bruggere, engineering group manager, and **Stephen Sweriing,** '63, technology director in the Service Instruments Division. Professor Thornton will serve as their first faculty advisor.

Of interest to many VI-A alumni/ae will be the department's decision to limit the future size of the program to about 250 students. This follows this past summer's peak when 288 were enrolled. The past two years' incoming classes have numbered about 100 each. Such a large enrollment has severely taxed the department's faculty in supporting the program both as VI-A faculty supervisors and as graduate thesis supervisors. As of this fall, 15 percent of the graduate student population in the department is made up of VI-A's. The limitations will be effected over the next three years by taking in only 85 new students per year. Unfortunately, this means that a number of companies who have applied for the program will not be able to join until a vacancy occurs, when a present cooperating company decides to leave the program.

One early December afternoon Director Tucker had a surprise visit from **Oscar P. Manley,** '56. He is head of engineering research — basic energy sciences for the U.S. Department of Energy. Also, he was in the first class to graduate when Mr. Tucker joined the M.I.T. staff in February 1956 as assistant to then-head of the Electrical Engineering Department, **Gordon S. Brown,** '31.

Attending M.I.T.'s VLSI Conference on December 15, and joining Mr. Tucker for lunch, was **Martin P. Lurie,** '78. Marty is with IBM, Essex Junction, Vt. Other VI-A's seen at the conference

included: **Richard B. Adler,** '43, associate head of Electrical Engineering and Computer Science, M.I.T.; **Dale C. Flanders,** '73, Lincoln Laboratories; **Mark T. Fuccio,** '80, Phillips Laboratories; **Brian D. Hamilton,** '79; **Theodore M. Lysczarz,** '74, Lincoln Laboratories; **Peter M. Osterberg,** '78; and **John J. Paulos,** '79.

While in Boston for a management training program, **Shahram Shirazi,** '75, called Mr. Tucker for a chat. Shahram is now with Bain and Co., Menlo Park, Calif., and his boss is **Vernon E. Altman,** '71. Also visiting the VI-A office were **Leonard N. Evenchik,** '77, who is with Bolt Beranek and Newman, and **Charles A. Kaminski, Jr.,** '70, who is with Creare Innovations in New Hampshire.

Up for a recruiting visit in October was **David M. Bernstein,** '74. He is head of signal design and detection in the Defense and Space Systems Group at TRW, Inc., Redondo Beach, Calif.— John A. Tucker, Director, Course VI-A, Room 38-473, M.I.T., Cambridge, MA 02139.

VIII
Physics

Joseph Robertshaw, Ph.D.'58, will have his second book published shortly, *Home Energy Management*; his first was *Problem Solving: A Systems Approach*. . . . **W. Murray Bullis,** Ph.D.'56, of the Department of Commerce's National Bureau of Standards, received the 1980 Edward Bennett Rosa Award of the Bureau, for "his distinguished and exeptional contributions to improving electronics standards through outstanding leadership and participation in the U.S. voluntary standards system."

X
Chemical Engineering

Hugh R. James, '74, reports that he is still vice-president of business development at the Pritchard Corp., has been working on joint ventures with Japanese companies, including trips to Kyoto, Kobe and Tokyo. . . . **Robert F. Sykes,** '44, has been elected a director of Volpex Corp., Pittsford, N.Y., a maker of plastic products and automotive and industrial parts.

XIV
Economics

Robert W. Pullen, Ph.D.'49, will retire as administrative vice-president of Colby College at the end of this academic year. He has been with the faculty since 1945 and has managed the fiscal affairs of the college since 1970. . . . **James E. Barron,** '42, of Ft. Myers, Fla., passed away on July 11, 1980.

Technology and Policy Program

Thanks to an anonymous alumnus, a $1,000 fellowship is being awarded to current Technology and Policy students.

Tariq Mahmood, is working for the New York State Energy Office, Albany, N.Y., as an energy policy analyst in the field of energy conservation. . . . **David Kagan,** is presently working as a project engineer in resource recovery and energy systems at the MITRE Corp., Bedford, Mass. . . . **Tatsu Suzuki,** is currently working for the International Energy Forum in Tokyo. He is a support staff/researcher in a project which deals with international energy policy issues, especially coal, nuclear and oil.— Professor Richard de Neufville, Chairman, Room 1-138, M.I.T., Cambridge, MA 02139.

Vote

MIT Alumni Association

1981 Annual Ballot

This ballot is to elect four new members to the National Selection Committee for three year terms.

The National Selection Committee's task is to select officers of the MIT Alumni Association: the President for a one year term; four vice presidents with alternating two year terms; and nine Directors from the nine electoral districts with alternating two year terms. And to nominate three alumni each year to serve for five year terms on the MIT Corporation.

Vote by mailing the ballot immediately (deadline May 22, 1981) to:
MIT Alumni Association
Room 10-110
MIT
Cambridge, MA 02139

Profiles of Candidates for Membership on the National Selection Committee

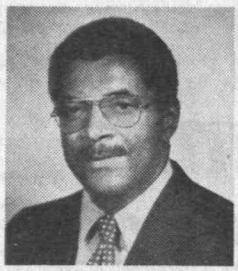
Vote for one in each district by using the ballot on the preceding page.

District 1

1

Elizabeth M. Drake '58
Chemical Engineering
Cambridge, MA
Vice President, Technological Risk Management
Arthur D. Little, Inc.
President, Alumnae Corporation, MIT Women's Independent Living Group, 1977- ; Nominating Committee Chairman, Assn. of MIT Alumnae, 1976-77, 1979-80; Technology Day Committee, 1980-83; East Campus Faculty Resident 1965-71; MIT Chemical Engineering Dept. Visiting Committee 1981- ; Steering Committee, Alumni Interfraternity Conference, 1980- EPA Science Advisory Board, Technology Assessment and Pollution Control Advisory Group, 1978-79; DOT Technical Pipeline Safety Standards Advisory Committee 1980- ; American Gas Association Liquefied Natural Gas Committee, 1974- . Registered professional engineer and member of A.I.Ch.E., A.C.S., A.A.A.S., and Sigma Xi.

Klaus Kubierschky '64
Electrical Engineering
North Reading, MA
Director of Engineering
American Science and Engineering Inc.
MIT Club of Boston, Director 1975-78, 1980-83, Executive Committee 1979- , President 1977-78, Secretary 1976-77; Alumni Council Term Member 1980-83, Member 1982; Chairman Regional Gifts Solicitation, Reading MA 1971-79; Member Alumni Council Program and Membership Committee 1979-82.



William H. Ramsey '51
Electrical Engineering
Newton Center, MA
Principal
WR Associates
Second Century Fund Solicitor for Newton Center MA 1961-63; Participant in Black Science and Technology Symposium 1973, 1975, Member of Planning Committee 1980; Member of Founding Committee of Black Alumni of MIT (BAMIT) 1980.
Newton Human Rights Commission, Past Member and Past Chairman; Norumbega Association, Past Director; Black Citizens of Newton, Member and Past Vice President; Charles River Health Care Foundation, Past Director; United Way Campaign, Volunteer 1973.

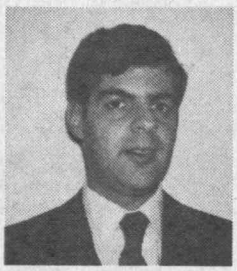
District 5

5

Kenneth F. Gordon '60
Sloan School of Management
Bethesda, MD
Director, Planning Office
National Bureau of Standards
US Department of Commerce
Bronze Beaver Award 1978; Alumni Association Board of Directors, District 5, 1976-78; Alumni Association Awards Committee, 1979- 82; Alumni Council Life Member; MIT Club of Washington, DC, President 1974-75; Vice President 1972-74, Director 1972- present; MIT Club of Rochester, Member 1965-67; Regional Gifts Solicitor, Bethesda MD 1977-78; Chairman, Personal Gifts Solicitation, Washington, DC 1978-79.
Chairman and Editor of Proceedings, MIT Symposium on Technological Innovation 1976. Member, World Future Society, AAAS, TIMS.

Louis F. Kreek, Jr. '48
Chemical Engineering
Wilmington, Delaware
Patent Attorney
ICI Americas Inc.
MIT Alumni Fund Board 1977-80; MIT Club of Delaware Valley, Member Executive Committee 1975-76 and 1980- , President 1978-80, Vice President and Secretary 1977-78, Third Vice President 1976-77; MIT Club of Northern New Jersey 1971-74; MIT Alumni Center of New York, Director 1975-77 and 1979-80; Class of 1948, Assistant Secretary 1978-83; Regional Gifts Chairman, Wilmington, Delaware 1974-77; Telethon Solicitor 1979-80.

Coralee Stevens Kuhn '70
Humanities
Silver Spring, MD
Attorney
MIT Club of Washington DC, Director and Attorney (pro bono) 1979- 81; Program Chairman for MIT Club Symposium on Deregulation 1979; Publicity Chairman for MIT Kennedy Center Concert 1976.
Served on White House Task Force for Regulatory Reform. Member: District of Columbia Bar; National Lawyers Club; Phi Delta Phi Legal Fraternity.

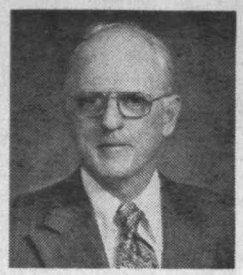


David A. Saar '70
Electrical Engineering
Baltimore, Maryland
Engineering Manager
Black & Decker Manufacturing Company
Patent Attorney
MIT Educational Council in Baltimore 1979- . Member, MIT Club of Baltimore. Member: IEEE, American Bar Association, Maryland State Bar Association, Baltimore Amateur Radio Club and Amateur Radio Emergency Service.

6

Frank E. Carroll '44
Civil Engineering
Barrington, IL
President and Board Chairman
Decks, Inc., and Carroll Research, Inc.
MIT Club of Chicago; Director 1970-73; 1977-80, President 1975-76, Past President 1976-77, Vice President 1973-75; Class of 1944, Vice President 1979-84; Regional Gifts Solicitor, Park Ridge, IL 1976-77; Solicitor MIT Leadership Campaign Chicago 1975-80.
Member: A.S.C.E., Tau Beta Pi, Chi Epsilon, Sigma Xi, and Scabbard and Blade.
Past President: Chamber of Commerce, Chicago Chapter American Subcontractors Association, Park Ridge IL Toastmasters Club; 1st Vice President American Subcontractors Association; Member; Union League Club of Chicago, Meadow Club of Rolling Meadows IL, Barrington Hills Country Club, Rotary Club, Board of Directors of Bank of Rolling Meadows.
Chairman of Troop 123 Boy Scouts of America of Park Ridge, IL 1965-66.

H. Bruce Fabens '44
Ocean Engineering
Mentor, OH
Retired
MIT Club of Cleveland; Director 1969-81; Educational Council 1961-81, Regional Chairman 1972-80; SCF Solicitor for Cleveland, OH 1961-63; Special Gifts Solicitor Cleveland 1974-76; Area Council Member Cleveland 1973-78.



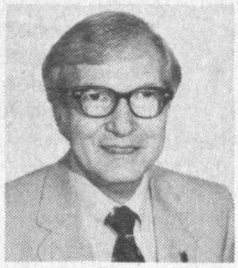
John F. Fennessey '47
General Engineering
Detroit, MI
Clinical Associate Professor of Pathology
Wayne State Medical School
MIT Club of Detroit, President 1964-65, Treasurer 1979-81; Educational Council 1972-74; Regional Gifts Sol. Detroit 1977-78; Friends of Sailing at MIT, Chairman 1980- .
Fellow, College of American Pathologists and American Society of Clinical Pathologists; Member, American Medical Society, Michigan Society of Pathologists, American Society of Law and Medicine, Wayne County Medical Society and Council, Member and Delegate, Michigan State Medical Society, State Bar of Michigan, Michigan Association of the Professions, Michigan State Bar Standing Committee on Medico-legal Problems; Catholic Physicians Guild of Detroit, Past President. Member, Crescent Sail Yacht Club, Detroit Yacht Club, Intercollegiate Sailing Hall of Fame; Detroit River Yachting Association, Rear-Commodore 1976, Vice-Commodore 1977, Commodore 1978, United States Yacht Racing Union; Associate Judge 1978-82, Senior Judge 1980- .

7

Parke D. Appel '22
Electrical Engineering
Venice, FL
Retired
Bronze Beaver Award 1964; Alumni Council, Member 1945-77, Life Member 1977- , Alumni Fund Board 1963-64; MIT Club of Southwest Florida, Director 1974-77, President 1977- ; MIT Florida Festival, Originator 1976, Coordinator Sarasota Area 1981; Class of 1922, President 1957 - Life, Reunion Chairman 1947, 1952, 1957, 1962, 1967, 1972, 1977, 1982, 50th Reunion Gifts Chairman 1968-72; Regional Gifts Chrmn, Sarasota FL; SCF Co-Chairman for Boston, MA 1961-63; MIT Boston Luncheon Club, President 1958-59, Sec-Treas. 1957-58.

Donald E. Burke '46
Aero and Astro
St. Petersburg, FL
Vice President
Fischer, Johnson, Allen & Burke, Inc.
Sustaining Fellows Founding Life Member 1980- ; Educational Council 1961- ; Solicitor, MIT Leadership Campaign, Tampa/St. Petersburg 1975-80; Personal Solicitation Program; Tampa/St. Petersburg, Chairman,1980-81; Regional Conference Member Tampa 1974-75; Presiding Chairman — First Florida Festival; MIT Club of Tampa Bay, Director 1967-74, 1975-79, Past President 1973-74, President's Council 1980- .
Florida Municipal Bond Council, Past President and Director.

Alan R. Crumley '72
Civil Engineering
Hato Rey, Puerto Rico
Consulting Geotechnical Engineer
Partner
Paniagua - Rodriguez - Garcia - Crumley
Secretary-Treasurer
Solum de Puerto Rico, Inc.
MIT Club of San Juan, President 1978-81; Vice President 1975-77.
Member, A.S.C.E., N.S.P.E.



James W. Frevert '48
General Engineering
North Palm Beach, FL
Certified Financial Planner and Account Executive
Thomson, McKinnon Secs. Inc.
MIT Alumni Activities Board Member 1980-82; Educatinal Council Member Palm Beach FL 1977-81; MIT Club of Palm Beach, Director 1980-81, President 1977-80, Secretary 1976-77.
Director International Association of Financial Planners 1975-81; Member Institute of Certified Financial Planners 1975-81; Volunteer Worker United Way of Palm Beach County 1980.

Marianna P. Slocum '55
Physics
McLean, VA
Senior International Program Manager
Department of Energy
MIT Alumni Association Board of Directors, Director District 7 1979-81; Ex-Officio Member Alumni Council 1980-81; Educational Council 1968-69; Regional Gifts Chairman McLean VA 1972-76; MIT Club of Washington DC, Director 1973-81, Vice President 1976-77, Treasurer 1973-74.

Ballot

Please return immediately!
Deadline May 22, 1981

Election of Members
of the
National Selection
Committee
3 year term

Vote for *one* in each district

Please validate your ballot by signing your name and class year. _____

District 1:
Boston Postal District

- ☐ Elizabeth M. Drake '58
- ☐ Klaus Kubierschky '64
- ☐ William H. Ramsey '51

District 5:
Pennsylvania,
Delaware, Maryland

- ☐ Kenneth F. Gordon '60
- ☐ Louis F. Kreek, Jr. '48
- ☐ Coralee Stevens Kuhn '70
- ☐ David A. Saar '70

District 6:
Michigan, Kentucky,
Illinois, Ohio, Indiana,
Wisconsin

- ☐ Frank E. Carroll '44
- ☐ H. Bruce Fabens '44
- ☐ John F. Fennessey '47

District 7:
District of Columbia,
Georgia, Virginia,
West Virginia, North
Carolina, South
Carolina, Florida,
Tennessee, Alabama,
Mississippi, West
Indies, All Islands in
the Caribbean

- ☐ Parke D. Appel '22
- ☐ Donald E. Burke '46
- ☐ Alan R. Crumley '72
- ☐ James W. Frevert '48
- ☐ Marianna P. Slocum '55

Suggestions for
future officers
All suggestions will
be transmitted to
the National Selection
Committee for their
consideration.

MIT Alumni Association
Room 10-110
Massachusetts Institute
of Technology
Cambridge, Massachusetts
02139

President

_____

_____

Board of Directors

_____

_____

Vice President

_____

_____

Alumni Nominees
to the
MIT Corporation

_____

_____

Puzzle Corner
Allan J. Gottlieb, '67

How to Play Red Dog

Allan J. Gottieb, '67, is associate research professor of mathematical sciences at the Courant Institute of Mathematical Sciences, New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10021.

As you may have known, I have been on leave from York College of the City University of New York since September, 1979, working on the ultracomputer project at the Courant Institute of Mathematical Sciences of New York University. Just yesterday I accepted an offer of a permanent position at Courant. This choice between C.U.N.Y. and N.Y.U. was one of the most difficult decisions in my life, for I have enjoyed working at both institutions. In the last analysis, however, the active graduate student and research programs at Courant tipped the scales their way.

Now that New York's financial situation has improved and the permanent York College campus is under construction, it looks as if the precarious times my colleagues and I suffered through in the late 1970s are finally over. I wish them all well, especially my fellow-members of the Mathematics Department; they certainly deserve it.

Problems

APR 1 We begin with a bridge problem from N. Piffenberger, who wants South to lead and make all remaining six tricks with hearts as trump:

	♠K 9 ♥K ♦4	
♠S J 10 ♥— ♦2 ♣J 6	♣A Q	♠A 8 ♥— ♦— ♣K 5 4 3
	♠— ♥A Q J ♦3 ♣9 7	

APR 2 Smith Turner wants some gambling advice. In the game of Red Dog, a player is dealt four cards and bets that he can beat a fifth one by having a higher card in the same suit. Bets won or lost are taken from or added to the pot. What is the probability of winning (before looking at the four cards)? How many of the 48 outstanding cards should a player be able to beat in order to justify betting? (For simplification, assume a two-handed game in which each player, after looking at his/her cards, must either pass (without penalty) or bet the exact amount then in the pot.)

APR 3 Matthew Fountain proposes the following scheduling problem, which he writes is "a real-life puzzle submitted to me in 1946 by an official scorer of a bowling league in Washington, D.C.": Make a round-robin schedule for 12 teams which bowl on six double alleys, two teams to each double alley per night. Each team is to meet every other team once, with no team bowling either more than twice or twice in a row on any double alley.

APR 4 This problem first appeared in *Technology Review* for January 1939 in an advertisement for Calibron Products, Inc.:

Two well insulated compartments, filled with a "perfect" gas, are maintained at absolute temperatures T_1 and T_2, respectively. If a large tube connects the compartments, the pressures (P_1 and P_2) naturally tend to equalize. But (believe it or not) if the proportions of the tube are suitably reduced, the dynamical theory of gases indicates that a steady state will be reached in which the relationship $P_1/P_2 = (T_1/T_2)^{\frac{1}{2}}$ is approached. Can you verify and explain this formula?

APR 5 Our last regular problem is a cryptarithmetic problem from Abe Schwartz: Substitute digits for letters to make the following addition correct:

```
  O N E
  T W O
+ S I X
-------
N I N E
```

Some additional restrictions: "ONE" is divisible by 1, "TWO" by 2, "SIX" by 6, and "NINE" by 9; and "NINE" > "SIX" > "TWO" > "ONE."

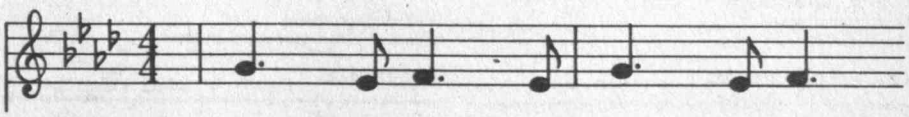
Speed Department

APR SD 1 A musical "quicky" from Smith Turner, who writes: 50 years ago a rite of autumn at our country club in Texas was a treasure hunt. Couples were given clues that led to further clues of increasing difficulty. One year four couples at the last clue were utterly baffled when another couple arrived, took one look at the strip below, and were off. Where did they go to win the treasure?

APR SD 2 We close with an amusing problem from James Landau: "Puzzle Corner" is occasionally accompanied by a box labelled "This Space Available for Your Listing." Since I work the problems on sheets of paper torn from old computer listings, I wish to take advantage of the publisher's kind offer. The box is 2¼ inches wide and $2^{9}/_{16}$ inches tall. My computer paper is 14⅞ inches wide and 11 inches tall. Question: How many times do I have to fold the paper in order to make it fit in the box?

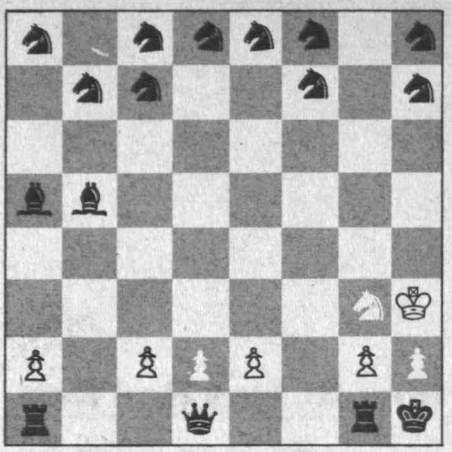
Solutions

NOV/DEC 1 Which reachable chess positions require the greatest number of moves to be



reached?

The proposer submitted a position which he claims requires at least 102½ moves to reach. The position is:



and his argument is as follows: since Black has ten knights, eight pawns must have knighted (this requires at least 40 moves). All eight of the Black pawns must have arrived at either QN7 or KB7, which implies that the pawns captured at least eight White men en route to the seventh rank. But White has lost only eight men. Thus all eight knightings must have occurred on QN8 or KB8. Now consider the current position of the ten knights. The two original knights started on KN1 and QN1; the other eight started on the White squares QN8 or KB8. For these latter knights, three moves are required to reach a Black square on the second rank, four to reach a White square on the second or first ranks, and five to reach a Black square on the first rank. It is not hard to see that the minimal number of knight moves is $5+5+4+4+4+4+4+3+2+2$ (the two 2s are for the original knights to reach KB1 and QB1). This gives a total of 75 moves for the Black pawns and knights. The rooks require three moves each, the bishops two each, the queen three, and the king 12 (the king can only approach the White pawns via QR6). Thus Black has made at least 102 moves. Since Black is in check, White made the last move. (Unfortunately, Clyde Kruskal and I noticed that the position is in fact unreachable, since the White King's bishop could neither have moved nor have been captured on its home square. However, we still feel that the solution is quite clever and hope that a small change can repair it.)

Winslow Hartford has also responded.

NOV/DEC 2 Suppose we are given the sequence
$S0 = \{1^n, 2^n, 3^n, \ldots\}$
and form the difference sequence
$S1 = \{2^n - 1^n, 3^n - 2^n, \ldots\}$
by taking the difference between consecutive elements in S0. Now form S2 as the difference sequence of S1, etc. Show that
$Sn = \{n!, n!, n!, \ldots\}$.

I have no choice but to use Joseph Keilin's solution, since he cites a book written by two Courant-trained mathematicians:
This is a standard result of numerical methods (see, for example, Isaacson and Keller, *Analysis of Numerical Methods*, pp. 261-62). For equally spaced data points $x_0, x_1, \ldots x_n$, let
$D^1f(x_0) = f(x_1) - f(x_0)$
$D^nf(x_0) = D^{n-1}f(x_1) - D^{n-1}f(x_0)$
$f^{(n)}(x) = df^n/dx^n$. Then
$D^nf(x_0) = (x_1 - x_0)^n f^{(n)}(x)$ for some x, $x_0 < x < x_n$.
For the special case of $f(x) = x^n$ and $x_1 - x_{1-1} = 1$, the result is
$D^nf(x_0) = n!$

Also solved by David Freeman, Winslow Hartford, Gerald Blum, and the proposer, Ten Clinkenbeard.

NOV/DEC 3 Five people had consecutive appointments with an income tax expert to help them

fill out their 1040 forms and schedules. The electrical engineer had income from a savings account. The man who had a profit trading commodities was taking educational expenses as a deduction. When the man who contributed to a charity was leaving he met the taxpayer with dividend income. The biochemist is deducting interest on a mortgage. The computer programmer uses an SC-40 calculator. When the man with the medical expense left, he met the man with the educational deduction. The man with four dependents owns a C1400 calculator. The man with three dependents is claiming storm damage as a deduction. The man with the charitable deduction followed the physicist. The man with five dependents exchanged amenities with the owner of the SR-50. When he looked at the tax expert's calendar, the man with the MX-140 noticed his name was next to that of the man with three dependents. The man with seven dependents sold some real estate for profit. The mathematician has six dependents. The income tax expert still had more than one scheduled appointment after he met the man with dividend income. Each man had a profession, owned a calculator, had a deductible expense, had some number of dependents, and had a second source of income. Who won money in the contest? Who owned an HP-45 calculator?

The following is from C. Muench:

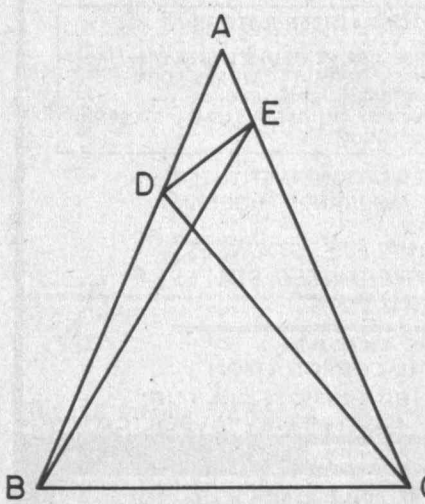
The physicist won the money in the contest and the mathematician owned the HP-45 calculator. A complete list of the order of visits and who owns what follows:

1. The physicist owns the SR-50, is deducting storm damage, has three dependents, and won money in a contest.
2. The electrical engineer owns the MX-140, is deducting charitable contributions, has five dependents, and has an income from savings.
3. The biochemist owns the C-1400, is deducting interest on a mortgage, has four dependents, and has income from dividends.
4. The computer programmer owns the SC-40, is deducting medical expenses, has seven dependents, and is reporting income from real estate.
5. The mathematician owns the HP-45 and has an educational deduction, six dependents, and profits from commodities trading.

But why are they all, including the income tax expert, men?

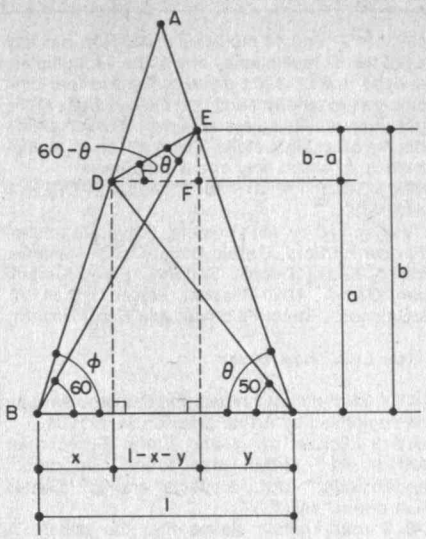
Also solved by Joseph Keilin, Harry Zaremba, David Freeman, R. Zlatoper, Michael Jung, Marcia Martin, Gardner Perry, Chris Ziegler, Steve Feldman, Marion Weiss, Mike Bercher, Harry Hazard, Philip Lang, W. McGuinness, and Winslow Hartford.

NOV/DEC 4 Given angle EBC = 60°, angle DCB = 50°, and AB = AC. Find angle DEB:



I received good looking solutions from Harry Zaremba and Norman Wickstrand, who obtained formulas that at first glance appeared different. However, they both agree on the special case solved by the proposer, Sheldon Katz, who determined that the answer is 30° when angle BAC is 20°. The solutions of Zaremba and Wickstrand follow in order:

Zaremba: Since AC = AB, triangle ABC is isosceles. In the figure, if we let angle DEB equal θ, then angle EDF equals $60° - \theta$. Also, let BC = 1 and angles ABC and ACB equal ϕ. Then,



$b = y \tan \phi = (1 - y)\tan 60$, from which

$y = (\tan 60)/(\tan \phi + \tan 60) = \sqrt{3}/(\tan \phi + \sqrt{3})$, and

$b = (\sqrt{3} \tan \phi)/(\tan \phi + \sqrt{3})$.

Similarly,

$a = x \tan \phi = (1 - x) \tan 50$, from which

$x = (\tan 50)/(\tan \phi + \tan 50)$, and

$a = (\tan \phi \tan 50)/(\tan \phi + \tan 50)$.

Thus,

$$b - a = [\tan^2 \phi\,(\sqrt{3} - \tan 50)]/(\tan \phi + \sqrt{3})(\tan \phi + \tan 50) \quad (1)$$

and

$$1 - x - y = (\tan^2 \phi - \sqrt{3} \tan 50)/(\tan \phi + \sqrt{3})(\tan \phi + \tan 50). \quad (2)$$

From the figure,

$$\tan (60 - \theta) = (b - a)/(1 - x - y). \quad (3)$$

Substituting (1) and (2) into (3) and using the following identity,

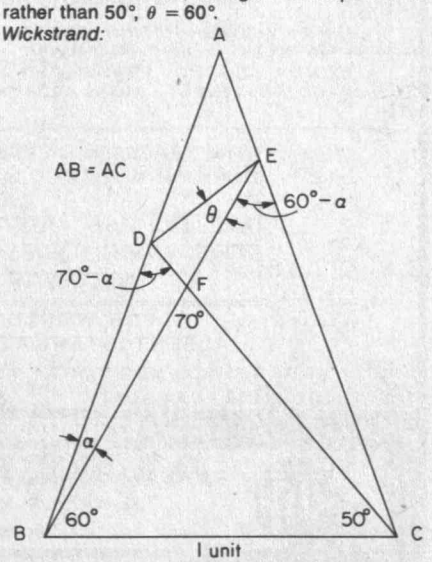
$\tan (60 - \theta) = (\tan 60 - \tan \theta)/(1 + \tan 60 \tan \theta)$,

we get for angle DEB:

$$\theta = \tan^{-1}\left[\frac{(\tan^2 \phi - 3)\tan 50}{\tan^2 \phi(4 - \sqrt{3}\tan 50) - \sqrt{3}\tan 50}\right]$$

Hence the value of θ is a function of the base angles ϕ, and we note that when $\phi = 60°$, $\theta = 0°$; and when $\phi = 90°$, $\theta = \tan^{-1}[(\tan 50)/(4 - \sqrt{3}\tan 50)] = 31°37'3.97''$. Also, if angle DCB equalled 60° rather than 50°, $\theta = 60°$.

Wickstrand:



$BF = (\sin 50)/(\sin 70) = .815208$

α	0	5°	10°	15°	20°	25°	30°*
θ	0	13°4′	19°28′	27°37′	30°	31°14′	31°37′

CF = (sin 60)/(sin 70) = .921605
DF = .815208 sin x/sin (70 − α)
EF = .921605 sin (10 + α)/sin (60 − α)
$DE^2 = DF^2 + EF^2 - 2DF \cdot EF \cos 70$
sin θ = sin 70 · DF/DE.

Hence the table at the top of this column, including $\alpha = 30°$ as the extreme case where AB = AC $\rightarrow \infty$. From that we determine that angle DEB (or θ) can be anything from 0° to nearly 31°37′.

Edward Dawson obtained yet another formula (this one in terms of B = angle ABC) that gives 30° when angle BAC = 20° (B = 80). Dawson's formula states that the cotangent of angle DEB is
[sin 60 · sin (B + 50) · sin (B − 50)]/
[sin 50 · sin 70 · sin (B + 60)] − cot 70.

Also solved by Winslow Hartford, Steven Goyeche, Andrew Combie, Joseph Keilin, Eugene Sard, David Freeman, Valeta Wheeler, John Fogarty, L. Upton, and Gerald Blum.

NOV/DEC 5 Replace each letter by a unique decimal digit to obtain a correct multiplication:

```
  S I N K
  T H E M
---------
D E E P D E E P
```

Emmet Duffy among others found this problem relatively easy:
Dividing the product by DEEP results in the number 10001 whose factors are the prime numbers 73 and 137. Then one of the numbers SINK or THEM is a multiple of 73 and the other is a multiple of 137. As K when multiplied by M results in P, differing from K and M, neither K nor M can be 0 or 1. Also, no digit is repeated in SINK or THEM. A list will be made of multiples of 73 and 137, which have four digits, none repeated, and do not end in 0 or 1. A hand calculator with repetitive addition is convenient for this purpose. There will be 27 multiples of 137 and 44 multiples of 73. Now multiply any of the 27 multiples by any of the 44 multiples, provided that all eight digits of the two four-digit numbers are different and that the two digits at the right when multiplied result in digit P which differs from the other eight digits. There will be 17 multiplications, of which only one is the answer:
SINK = 5069; THEM = 2847; and DEEPDEEP = 14431443.

Also solved by Avi Ornstein, Steven Goyeche, Winslow Hartford, Gerald Blum, David Freeman, Joseph Keilin, Dennis Sandow, Frank Carbin, Harry Garber, Allen Wiesner, Lester Nathan, W. McGuinness, Steve Feldman, and Harry Hazard.

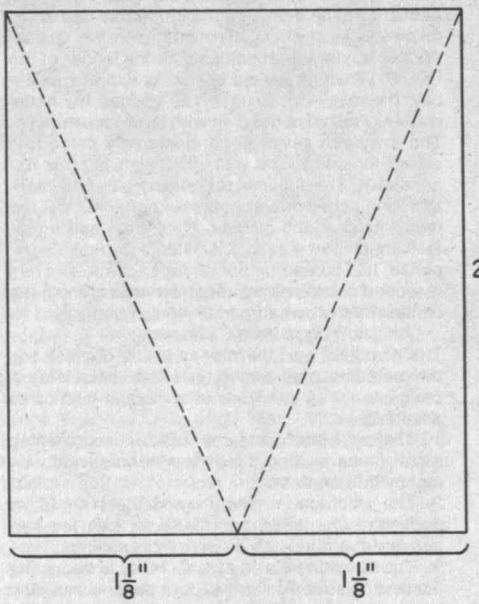
Better Late Than Never

MAY 1 Martin Lubell notes that this problem was first composed by Arthur MacKenzie in 1904.
MAY 3 Michael Jung and Frank Rubin offer "amyotonia." Rubin also found "oogonia," "aposiopesia," and "alopecia areata." Gerald Blum offers "aalii."
A/S 3 Joel Freilich claims that the square is unique if an obtuse angle can be found with two of the points on one ray and the other two points on the other ray.
A/S 4 Michael Jung has responded.
OCT 4 Hugh Tett has responded.
Y1970 Mike Bercher has responded.
NOV/DEC SD 1 Dennis Sandow feels that a self-employed master carpenter would have cut the wood to leave the most useful remaining scrap.

Proposers' Solutions to Speed Problems

APR SD 1 The music was recognized as from "Tea for Two," in the then-current musical comedy "No, No Nanette," and the words corresponding to the seven notes are, "tea for two and two for tea." Thus the couple drove off to the tee for hole two (of the country club's golf course). Since this was before wood and plastic tees, each tee had a box of sand used for scrubbing the ball and then teeing it up. The couple proceeded to dig in the sand for the treasure.

APR SD 2 Twice. Fold it in half twice, top to bottom each time, giving a rectangle 14⅞ inches wide by 2¾ inches tall. Let it open into a V-shape and stand it on end. It will fit into the box.



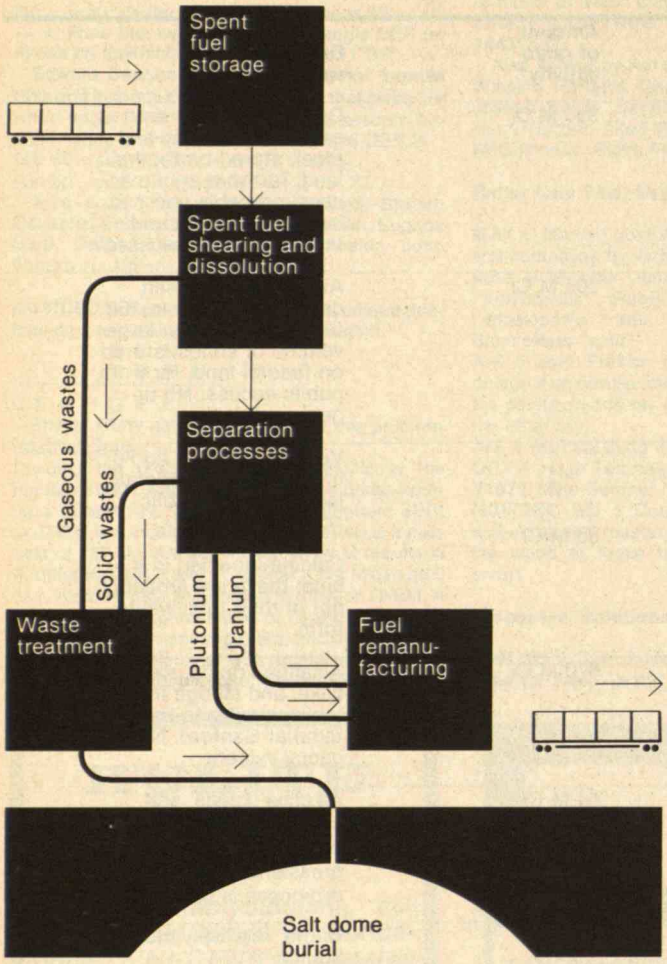
Each of the dotted lines is 2.79+ inches long, or about 1/20 inch longer than the computer paper. Each sheet has a thickness of about 1/200 inch.

Source	Location	Amount	Amount of radioactivity*	Description of waste form now
Weapons production	Hanford Works, near Richland, Wash.	250 metal capsules	350 M Ci	Ceramics doubly encased in hastelloy and steel; stored on federal land, far from public access, probably never to be re-opened. Should they be further encased?
		50 million gallons	200 M Ci	Alkaline liquids, salt cake, and sludge in 168 tanks. Very dilute, large volume of solids; stored on federal land, far from public access. No urgency evident.
	Idaho National Engineering Labs near Idaho Falls, Ida.	2.5 million gallons of liquid	85 M Ci	Very dilute, clear liquid in 11 tanks; on federal land, far from public access.
		0.5 million gallons of solid		Calcine (powder) in 4 bins; these are *probably* not in their final waste form.
	Savannah River Works, near Aiken, S.C.	25 million gallons	570 M Ci	Alkaline liquids, salt cake, and sludge in 33 tanks, similar to the material at Hanford. No urgency evident.
Commercial fuel reprocessing	Nuclear Fuel Services, West Valley, N.Y.	0.6 million gallons	64 M Ci	Alkaline liquids, salt cake, and sludge near public access. Congressional action to reprocess is pending.
		1 million gallons	1 M Ci	Dilute, relatively clear liquids.
		1,000 gallons	10 M Ci	Slurry of fuel pellets and metal scraps. Little research completed to date.
Commercial reactor operations	70 reactor sites throughout the U.S.	6,500 tons of metal	2,800 M Ci	Spent fuel in original cladding and racks, stored under water. No plans at present to reprocess or dispose. Additional storage capacity needed at some sites to accommodate 2,000 tons being added every year.

*1 megacurie (M Ci) = 3.7×10^{16} disintegrations per second.

The U.S. inventory of nuclear wastes. If we exclude the mill tailings at uranium mines, the problem of nuclear waste begins with spent fuel from a nuclear reactor, which can be reprocessed to yield uranium and plutonium. Some 100 million gallons of diluted waste liquids resulting from reprocessing for military operations now awaits final disposal. In addition, the national inventory includes 6,000 tons of spent fuel from civilian nuclear reactors, none of which has been reprocessed because of fear that the plutonium might be used illicitly for weapons. These spent fuel rods accumulate at the rate of 2,000 tons a year at reactors throughout the U.S. because the issue of plutonium proliferation, not waste disposal, remains unresolved.

An enormously wasteful atmosphere of urgency will be a source of continuing frustration.



An integrated nuclear-fuel-reprocessing and waste-disposal system — the Entsorgungszentrum — proposed for Gorleben, West Germany. For more than a decade, West German low-level radioactive wastes have been stabilized and entombed in an abandoned salt mine in Asse, Lower Saxony. To replace that system and to deal with spent fuel from Germany's nuclear power plants, 12 German public utilities are now proposing to sponsor construction of a plant to contain this ambitious system. The plant will store spent nuclear fuel, reprocess it at the rate of 1,400 tons a year to release uranium and plutonium, manufacture new fuel from these recovered products, solidify radioactive wastes, and dispose of them in a virgin salt dome directly beneath the factory. The plans have been temporarily set aside because of opposition to nuclear power in West Germany.

than-adequate immobilization of the radionuclides.

The alternative is to bury the wastes on-site after solidifying them into a low-temperature waste form. This system calls for reacting the waste liquids with silicate or phosphate additives as cementing agents in copper canisters with walls about two inches thick. These inert copper canisters could then be disposed of in horizontal tunnels at Hanford or concrete-lined mined caverns in the bedrock below Savannah River.

A System with Time in Our Favor

Anyone interested in understanding recent changes in plans for radwaste management should bear in mind three main points:

☐ Radwaste disposal must be treated as a system. Isolated discussions of a preferred rock type, waste form, or canister material are meaningless.

☐ Ceramics and concrete have joined glass as the major options for immobilization and encapsulation of radwaste into waste forms, and engineering of the waste form can and must be considered of equal importance with geologic isolation.

☐ The atmosphere of urgency in the United States has been enormously wasteful and will be a source of continuing frustration. Legal, regulatory, and funding problems guarantee that no permanent waste repository can open before the year 2000. In the meantime, there is virtually no danger from the wastes as they now exist; in fact, the management problems they present grow simpler with each passing year as their radioactivity decreases.

Research to determine the optimal solution among the many promising technological options will require at least five or ten years. What the nation needs now is an articulated waste-disposal plan, a central, modest research-and-development program to clarify uncertainties, and a nationwide educational program conducted by colleges and high schools to achieve understanding (in place of massive misunderstanding) of the real problems and our options in resolving them.

Rustum Roy is Evan Pugh Professor of the Solid State and director of the Materials Research Laboratory at Pennsylvania State University. He joined Penn State's geochemistry faculty in 1950, two years after receiving his Ph.D. in ceramics; he received earlier degrees from Patna University in India. In addition to his work in materials research, Professor Roy is chairperson of Penn State's Science, Technology, and Society Program.

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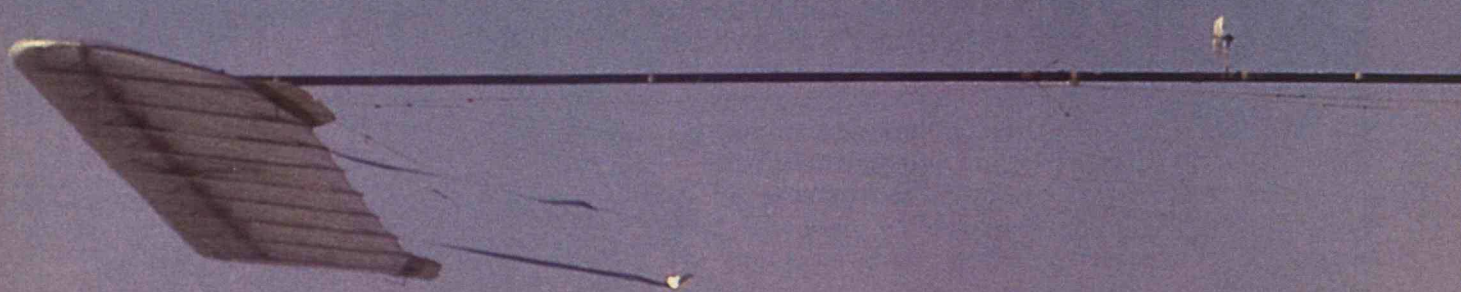


Building the *Gossamer Albatross*

by Morton Grosser

On June 25, 1909, at 4:41 A.M., Louis Blériot took off from Les Baraques near Calais in his frail *No. XI* monoplane powered by a three-cylinder, 25-horsepower Anzani engine. "*Pendant une dizaine de minutes, je suis resté seul, isolé, perdu au milieu de la mer écumeuse, ne voyant aucun point à l'horizon, ne percevant aucun bateau.*" ("For ten minutes I remained alone, isolated, lost in the midst of a foaming sea, unable to distinguish a single point on the horizon, or see a single boat.") At 5:17.30, after a meandering and chancy flight of 37.8 kilometers (23.5 miles), Blériot's plane glided to a landing and gently nosed over in the Northfall Meadow near Dover Castle.

There was no precedent for the radical technology in Paul MacCready's second human-powered aircraft. But *Gossamer Albatross* began its fitful quest for the cross-Channel prize by flying "right off the board."

For the greatest naval power in history, those were 36 minutes that changed the world.

During May and June 1979, many members of the *Gossamer Albatross* team made a pilgrimage to the obscure monument at the spot where Louis Blériot had landed. They, like Blériot and Louis-Pierre Mouillard (who studied the flight of soaring birds in the 1880s), found that the problem of human flight was a haunting, all-consuming passion that preempted every idea once it occurred. Already their *Gossamer Condor* had redeemed their convictions and the dreams of countless romantics by winning Henry Kremer's prize for the first human-powered flight. But the obsession persisted, and so

Overleaf: Bryan Allen flying *Gossamer Albatross* at Harper Dry Lake, California, in April 1979. When it made its final flight in California before being crated for the trip to England for the cross-Channel attempt, Paul MacCready's *Gossamer Albatross* weighed in at just under 60 pounds. Of that total, its avionics package — two-way radio, airspeed and altitude instrumentation, and cables and connectors — represented 1.5 pounds. Its wingspan was 93 feet 10 inches — longer than that of a 727 transport. Its longest flight had lasted 1 hour, 9 minutes, and 3 seconds — by far a world record but by no means long enough (at about 10 mph) to conquer the English Channel. (*Photo: Anton Higgs*)

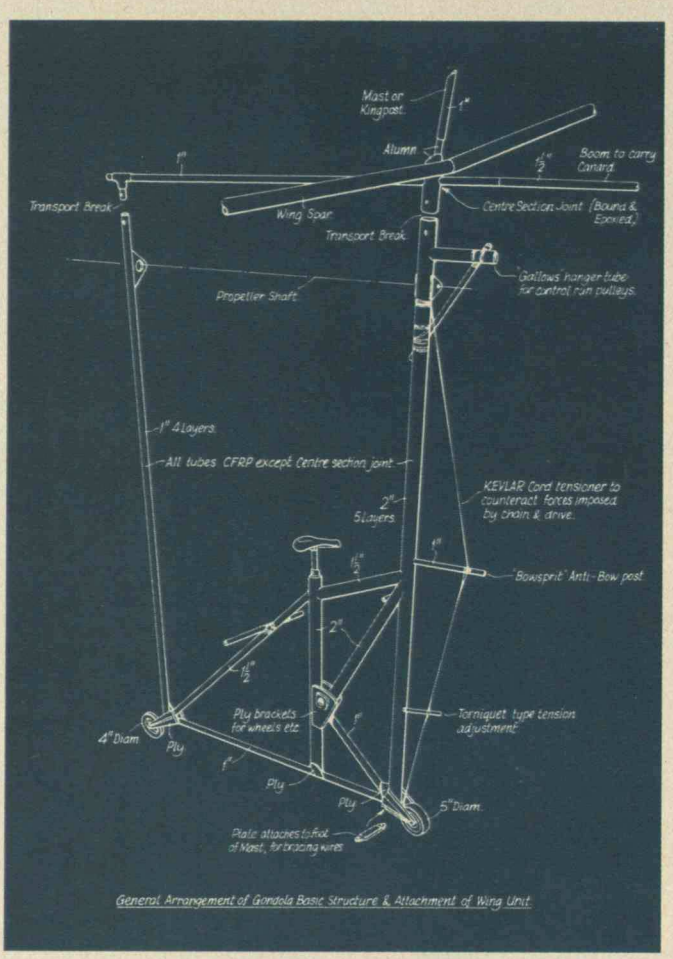
the team was now in England with a new craft named the *Gossamer Albatross*.

Only two weeks after the *Gossamer Condor*'s successful flight, Henry Kremer offered two new aviation awards to the Royal Aeronautical Society. One was a prize of £10,000, for the next human-powered flight around the figure-eight course by anyone other than a citizen of the United States. The other was ten times larger: £100,000 for the first successful human-powered flight across the English Channel. And Paul MacCready, who had already received Henry Kremer's congratulations for the "brilliant design" of the *Gossamer Condor*, was prodding himself to improve it: "Let's build the ultimate." By mid-October he had begun making notes for a human-powered Channel crossing: "Fly 12 mph, HP 0.2. Takes 2.7 hours (say two hours with light helping wind)." And by the time Dr. MacCready returned from London after receiving the first Kremer Prize, he had resolved that the next time there would be no holds barred on advanced technology.

From Aluminum to Carbon

By November 1977, Paul had established the proportions of a second-generation human-powered airplane. In mid-December, he and two colleagues from the *Gossamer Condor* project decided to use the same airfoil as the *Condor*, a similar but narrower-bladed propeller, and a horizontal bowsprit to lower the parasitic drag. They also decided to use carbon-fiber-reinforced plastic (CFRP) spars instead of aluminum tubing for the airframe. This meant that much of the technology would have to be invented, because it was impossible to buy such exotic components off the shelf.

The carbon-reinforced material consists of thousands of minute carbon filaments held side by side in a matrix of uncured epoxy resin. In uncured sheet form, it has the sheen of well-brushed black hair, a slightly sticky feel, and the disconcerting limpness of a thin sheet of licorice. To make a load-bearing member from carbon-fiber sheet, one must form it around a matrix or inside a mold, hold it in place, and heat the assembly until the epoxy resin softens and then cures into a rigid structure. It would seem to be a great nuisance — except that carbon fibers have astonishing rigidity and tensile strength for their weight.



General Arrangement of Gondola Basic Structure & Attachment of Wing Unit

Seven concepts governed Paul MacCready's design of the *Gossamer* aircraft, according to Morton Grosser in *Gossamer Odyssey:*

☐ Use a big, single-surface wing for high lift and light wing loading at a low flying speed.

☐ Brace the wing spar with wire stays from the ends of a king post, a bottom post, a keel tube, and a bow-sprit, like a hang glider.

☐ Mount the canard stabilizer at the forward tip of the bowsprit, thus giving it maximum pitch-control moment with the least additional structure.

☐ Position the propeller high up behind the wing, to give it adequate ground clearance and a clean slipstream.

☐ Locate the pilot directly under the center of lift so that his weight provides some pendulum stability.

☐ Make every part as light as possible.

☐ Try the easiest solution to each problem first.

The drawing shows how these principles are fulfilled in the design of the basic gondola structure of the *Gossamer Albatross*. (*Drawing: A.A.P. Lloyd*)

A comparison of average values shows that a unidirectional CFRP has a density of .055 pounds per cubic inch, a little more than half that of a typical aircraft aluminum alloy. It has an ultimate tensile strength of 200,000 pounds per square inch, 3.225 times that of the same alloy. This means that its specific strength (ultimate strength divided by density) is 5.86 times that of the material of the *Gossamer Condor* airframe. Simply put, the carbon-fiber structure offers almost six times more tensile strength per unit of weight than aircraft aluminum.

Because of this remarkable strength-to-weight ratio, CFRP appeared to be a particularly appropriate material for a human-powered plane. One of the major obstacles to using it was size. Commercially produced CFRP tubes for golf club shafts and fishing rods are wound on tapered steel mandrels, heated to cure, and slipped off the mandrels. But since MacCready's new aircraft needed wing-spar sections at least 24 feet long with a constant diameter of 2 inches, steel forms seemed impractical.

A Superb Structural Element

During February 1978, Kirke Leonard of the *Gossamer Albatross* team developed an ingenious technique for forming tubular CFRP spars of the required size — a "Rube Goldberg" tube-winding machine. To form a spar, a 12-foot length of aircraft aluminum tubing of the appropriate diameter is inserted in the machine and clamped between its centers. Then epoxy-impregnated carbon-fiber sheet — "prepreg" is its generic name — is fastened to the mandrel at one end and wrapped on the slowly rotating tube in a tight spiral. Kirke's machine allows the operator to control three variables simultaneously: tension, wrapping angle (usually 16 degrees), and amount of overlap. Each layer of prepreg is 0.007 inch thick, and several layers are wrapped diagonally over one another until the tube looks like a section of bicycle handlebar. A combination of computer analysis and cottage industry allows the placement of handmade but optimal reinforcements at areas of high stress. These include elliptical pads where brace wires are to be attached and graded cuffs at the ends where the spar sections will join.

After the carbon-fiber sheet is fastened firmly at both ends, the entire tube is bound with transparent shrink tape that locks the prepreg tightly in place and forms a glass-smooth surface mold for the epoxy resin. To cure the resin, the taped assembly is placed in one of the team's most disreputable-looking appliances, an oven improvised from a 15-foot length of large-bore aluminum tubing, with a resistance heating element controlled by a Variac at approximately 40 volts. The shrink-taped spar is baked at 290° F as measured by two candy thermometers in the end plugs of the heating tube. In one hour, the epoxy has softened and cured to a beautiful mirror-black finish, fusing the layers of fiber-impregnated sheet into a rigid structure.

After the assembly has been removed from the oven and cooled, the shrink tape is stripped off and the spar slid into a capped length of PVC plastic sewer pipe. The pipe is filled with a 10 percent hydrochloric acid solution (bought in bulk from swimming pool cleaning services), and the aluminum mandrel is dissolved out from the inside of the spar.

Although the production equipment looks crude, the result of this process is a superb structural element that can be tailored exactly to the job it must perform. Depending on the part of the plane a tube was destined for, it could have different numbers of carbon-fiber layers — three to five was the most common range — and different reinforcements. To complete the wing spars, the 12-foot tube sections were spliced together with short aluminum inner sleeves and carbon-fiber wrapped and heat-fused into 24-foot lengths. Epoxy-coated styrofoam plugs were spaced at approximately 10-inch intervals inside the large-diameter tubes. The plugs weighed very little, but they greatly increased the tube's resistance to buckling.

The propeller shaft gives a good indication of the CFRP tubing's performance. It is close to a wing-spar module in size: 10 feet long by 2 inches in diameter. When Bryan Allen, the pilot, pedals hard at takeoff, the shaft must transmit a peak shear force of approximately 5,000 pounds from the chain sprocket to the propeller. The shaft's total weight is 475 grams — just over 1 pound; it can easily be balanced on one's little finger.

While Kirke Leonard was experimenting with CFRP, Paul McKibben of the *Albatross* team was designing a light, strong thimble-and-wire termination that would allow the new plane to be rigged and unrigged quickly. And Leonard was experimenting with an extremely strong Du Pont aramid fiber called Kevlar for control cables, bracing-wire con-

nections, and component reinforcement. The Kevlar was supplied in many different forms, and before long the construction crew found uses for it that its manufacturer never dreamed of.

In keeping with the new technology, Leonard and others designed all-plastic ribs for the new wing. Assembling them was like magic. The blank for a center rib was 5.5 feet long and cut from a one-quarter-inch-thick sheet of expanded polystyrene foam with a hot wire. It weighed 20 grams — less than a first-class letter — and was as fragile as a giant piece of meringue. On the side of this pristine white airfoil, thin black lines of carbon-fiber tape were contact-cemented in the shape of a diagonal truss. It looked like a lecture in statics when the professor draws a truss on the blackboard, but in this case the truss was instantly real. When the rib was capped with the same narrow carbon-fiber strips, fitted with a thin plywood spar ring, and bound with Kevlar cord at its trailing edge, it weighed about 1.7 ounces complete, but it was a full-fledged load-bearing member of remarkable strength.

Bryan Allen could be described the same way. While the parts of the new plane were taking shape, its chief pilot was improving his training regime. By June 1978, Bryan was putting out 0.31 horsepower continuously for two and a half hours. That was more than enough, by MacCready's reckoning, to fly the English Channel.

From Penguin to Albatross

Early in July 1978, most of the parts for the first model of the craft that Paul MacCready (but no one else) called the *Gossamer Penguin* were complete. At a staff meeting on July 16 (to assure that they were democratic, definite, and short, there were four rules for such meetings: all meetings are held standing in a circle, all participants are heard in turn, all meetings must result in at a definite decision, and all decisions must be acted on immediately), the *Penguin* name was vigorously criticized. In the face of nearly unanimous rejection, Paul MacCready surrendered; and Bryan Allen was among the successful advocates for the name that the team eventually decided on, the *Gossamer Albatross*.

The team spent the rest of that day assembling and rigging the new airplane, and at 8 P.M., just as the sun was setting, the *Gossamer Albatross* took off for its first tuning tests. Even though some of the parts were jury-rigged substitutes and the fuselage was uncovered, the plane flew right off the board, a much more encouraging debut than that of the *Gossamer Condor*. Parker MacCready, Paul's son, was the pilot, and he said it was very easy to fly.

After six short hops to determine the optimal wing incidence (6 degrees) and rigging angles, the plane was weighed in at 60 pounds (27.7 kilograms). Paul MacCready was disappointed with this figure, and noted that part of it was due to the use of an old, large stabilizer that was 5 pounds overweight, and also to "miscellaneous crummy fittings and wires and ropes," which added about 2 pounds.

Putting Plastics in Flight

Though the *Gossamer Albatross* had the same general layout as the *Gossamer Condor*, it was a radically different aircraft. A good analogy would be the Boeing 720, which most laypeople regarded as a modified version of the Boeing 707 but which was in reality a major redesign.

First, the *Gossamer Albatross* was virtually an all-plastic machine. The only metal parts were the pedals, cranks, and chain sprockets, the post for the Stella Italia bicycle seat, the thin cables molded into the drive chain, the stainless-steel bracing wires, and a few fittings. Its skeleton was CFRP tubing. The leading edges of the wing and stabilizer were heat-formed from expanded polystyrene foam sheet, and the ribs were made of the same material braced with carbon fiber and Kevlar. The final version of the propeller used a carbon-fiber spar inside a core of dense blue polystyrene foam; the blades were skinned with Kevlar cloth. The control lines were braided Kevlar, the wheels and the canard antiyaw cords were nylon, and the drive chain was molded polyurethane. Even the aluminum control-cable fairleads and pulleys used on the *Condor* were redesigned in Du Pont Teflon and low-friction Delrin acetal resin for the *Albatross*. The pilot's windshield was transparent vinyl, and the plane was covered with various thicknesses of Du Pont polyester film —a new differentially tensilized Mylar used as the base material for audio tapes. It would have been impossible to produce the *Gossamer Albatross* as recently as ten years ago, because some of its materials did not then exist and nothing else offered the same properties.

In addition to materials changes, there were many

Trying it on for size. A year after the successful cross-Channel flight, with *Gossamer Albatross* safely back in its California desert surroundings, pilot Bryan Allen (*left*) introduces author Morton Grosser to the comforts of the *Albatross* cockpit. (*Photo: Janet Grosser*)

changes in configuration between the *Condor* and *Albatross*. Perhaps the most obvious was pilot position. The *Albatross* has a fully enclosed streamlined cockpit ten feet high and eight feet long, which allows the pilot to pedal in a normal upright cycling position. The decision to change from the *Condor*'s supine posture was confirmed by ergometer tests, in which Bryan Allen's power output and oxygen consumption were compared in both attitudes. His peak short-period output pedaling upright was 1.6 horsepower for six seconds, as opposed to 1.3 horsepower for the same period supine.

Although the same airfoil was used on both airplanes, the wings of the *Albatross* have only two-thirds the area and much less taper than those of the *Condor*. They are swept back 7.5 degrees instead of 9 degrees, and they are covered with biaxially tensilized Mylar that shrinks more lengthwise than crosswise when heated. The Mylar is applied with the higher shrink direction aligned along the wingspan. This allows the film to be tightened to provide a smooth boundary-layer surface, and also maintains the airfoil contour more accurately by preventing dips between the ribs. The ribs at their rear tips are connected by a 0.022-inch transverse wire that forms the trailing edge of the wing. When the Mylar covering is tightened, the flexible trailing edge is drawn into shallow curves between the ribs (the familiar "bird wing" look of World War I aircraft), and the spar and the leading edge are pulled back in a slightly convex line.

The stronger and lighter carbon-fiber spars of the *Albatross* allowed the substitution of internal Kevlar cord braces for the *Condor*'s external wing bracing spreaders and the use of a longer, less drooped nose boom to support the canard. These changes meant that despite the experience of the crew from the *Condor* team, there were still many lessons to be learned about the new airplane.

He Could Have Flown an Hour

By July 22, when the team gathered again for test flights, there were still some flaws that the crew hadn't had time to fix: the lower rear section of the fuselage was missing its covering, and there was a slight bend in the aluminum propeller hub shaft. (Paul MacCready suspected that the tubing had not been checked to make sure that it was 6061-T6 and not a softer alloy.) At 7:45 P.M., Bryan made a short flight to check the controls and found that the cords needed tightening and balancing. The lines were adjusted, and 15 minutes later Allen took off again and flew for more than a minute at a height of 5 feet in a series of S-turns; the crew estimated the plane's speed to be 12 miles per hour. "First true flight. Very easy," the pilot's log notes. To Paul, Bryan reported that he "could have flown an hour."

The next evening when Bryan took off into the wind, which was still gusting slightly, the hub section of the propeller shaft failed, confirming Paul's suspicion. While a replacement shaft was being made, Paul MacCready and other members of the team analyzed other teething problems of the *Albatross*. A rerun of the speed calculations showed that the plane actually flew at about 10 miles per hour, slower than expected. Bryan also felt that the

controls were imprecise and sticky. Paul outlined a major redesign program for them but postponed any hardware changes until after the next test flights. He was determined to push up the plane's flying times and try for some duration records.

On August 4, Parker MacCready made two brief flights with the new propeller shaft and a new drive chain, reporting that the plane was easy to pedal. Finally, on August 11 came the needed duration tests. Parker made a 1-minute warm-up flight and then took off over a (6.5-foot) T-bar and flew for 3 minutes and 44 seconds, most of it at an altitude of 20 feet. In the middle of the flight he made a complete 360-degree turn, but when he landed he reported that the pitch control was out of balance. Bryan Allen then took off like a human-powered rocket, going up on the elevator to 25 feet, and flew for 4 minutes and 40 seconds. He cut the flight short because of the pitch control adjustment and noted in his log that while the pedal effort was easy, the canard tended to overbank. (The normal angle of bank is 9 degrees to either side. The adjustment of the *Albatross*'s stabilizer had to be determined empirically, because unlike most canard control surfaces, it operated at a lower coefficient of lift and a lower angle of attack than the main wing.) Bryan made several shorter flights, trying S-turns in both directions, but still found the controls unsatisfactory for a longer flight.

The next morning, Sam Durán tried a takeoff and stalled out when the canard overcontrolled in pitch. He made a short second flight and, like everyone else, reported that the pedaling effort was low. Bryan then took off strongly, climbing to 20 feet and cruising at that altitude for two minutes. As he started to make a left downwind turn, the warp control jammed and the canard locked in the left roll position. The *Albatross* went into a steep left spin and dove into the runway at full speed. It was the worst crash in the history of the *Condor* and *Albatross* teams, and it seemed to sap the morale and energy of the project. The *Gossamer Albatross* would not fly again for five months.

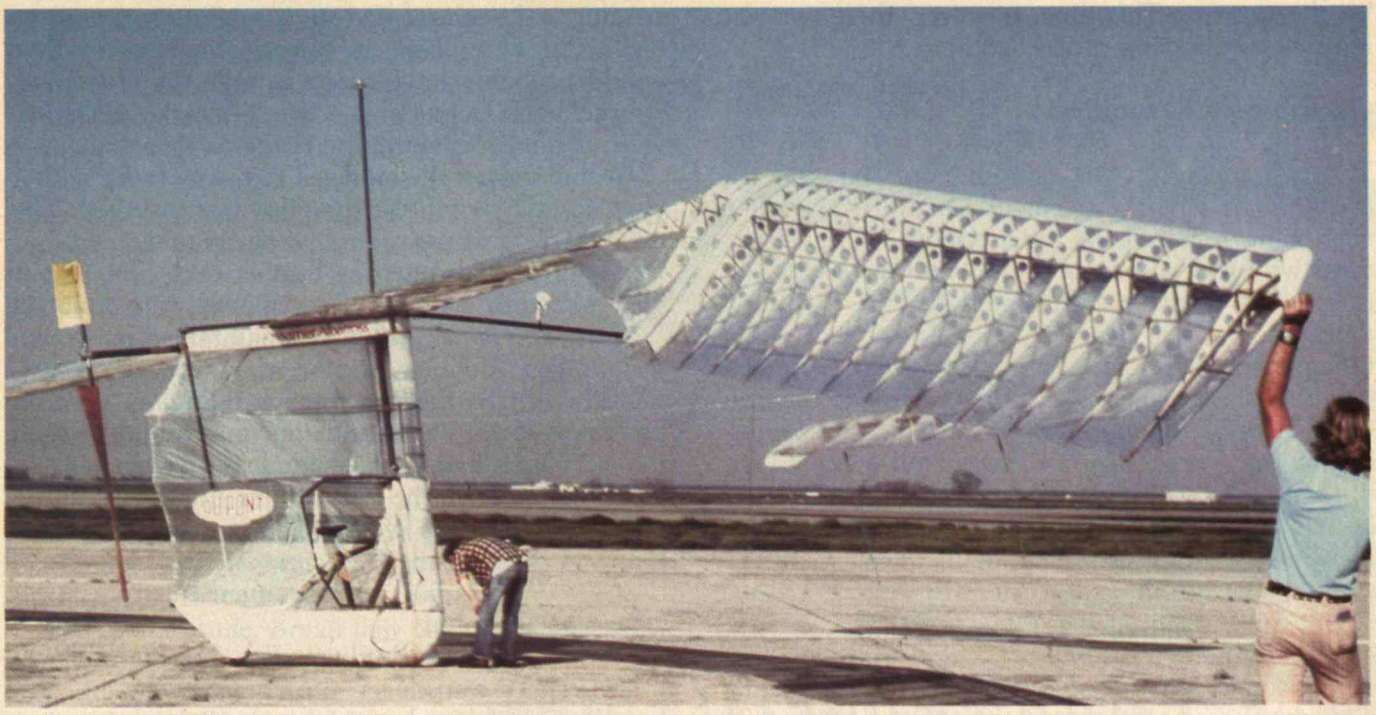
From the Mainland of the U.K. to the Mainland of France

By mid-January 1979 the *Albatross* was repaired and reassembled. Bryan checked it out in a series of short flights designed to measure the tension in the brace wires and to calibrate the speedometer. These flights also turned up a number of flaws, the correction of which occupied the crew for several weeks. There followed a series of disastrous flights, culminating on February 17 in the third major crash in the wonder plane's short career. Thus far it had not equalled the longest flight of the "primitive" *Gossamer Condor*; in fact, it had never flown as long as five minutes.

Meanwhile, the rules for the £100,000 Kremer Cross-Channel Competition had been issued by the Royal Aeronautical Society. The course was simple: "From the mainland of the U.K. to the mainland of France." The aircraft was to take off from a location in the United Kingdom approved by the U.K. Aircraft Owners and Pilots Association (AOPA), not more than 30 meters above mean low water level. That is, a takeoff from the top of the White Cliffs of Dover, or any other cliffs, was prohibited. A starting ramp less than 6 feet high was allowed, as was takeoff from a ship or the water, provided that the aircraft circled back over England and an official observer before heading for France. The lowest part of the aircraft was not permitted to exceed a height of 50 meters above the sea for any period of three minutes; i.e., no thermal gliding was permitted. To complete the flight, the aircraft had to land on a part of the French mainland uncovered by the sea at that time; tidal sands were allowed. The flight had to be continously observed from takeoff to landing by one or more observers certified by the AOPA.

The aircraft had to be heavier than air and carry no energy storage devices, hot air, or lighter-than-air gases. It had to be powered and controlled entirely by its crew over the entire flight, receive no aerodynamic assistance from any outside vehicle, and jettison neither parts nor persons during the flight. Three members of the ground crew were permitted to stabilize the plane during takeoff (but not to accelerate it). There was no limit to the number of flying crew, as long as they used no drugs or stimulants and stayed aboard for the entire flight.

In addition, before the Channel attempt, contestants were required to make a qualification flight of at least two minutes' duration or 400 meters (437 yards) over level ground, with the craft reaching a height of 2 meters (6.5 feet). That, at least, Paul thought, ought to be a piece of cake. But there were only ten weeks remaining before the May-June weather window that British meteorologists felt would be the optimal time for an attempted cross-Channel flight.



Picking up the pieces after the worst crash in the history of the *Gossamer* teams on August 5, 1978. The pilot, Bryan Allen, was not seriously injured, but *Gossamer Albatross* was severely damaged when the warp control jammed in flight. The fuselage was totally destroyed — the vertical post was broken, as were the wing spar, the kingpost, and the bowsprit in two places. The canard (not shown) was damaged, the wing leading edge was crumpled, a number of ribs were smashed, and one propeller blade was broken. (*Photo: Don Monroe*)

The Etch Tank Gurgles Again

The flight program of the *Albatross* had reached an impasse, and the temper of its pilot had reached the boiling point: on February 21 Bryan Allen sent Paul MacCready a carefully worded but scorching four-page letter, accusing him of mismanagement, lack of direction, poor communication, refusal to delegate authority, and capricious design changes. "We should have an obligation to our sponsor and to ourselves that we do *everything*, whether it be design, construction, flight testing, promotion, or repairing, *to the absolute peak of our abilities*," he wrote.

Ironically, Paul MacCready's own philosophy agreed completely with the last statement, and he treated Bryan Allen's indictment as a well-deserved reproof. On February 24 he drafted a new management plan for the *Albatross* project, one major plank of which was to "get more people," and he promptly fulfilled that commitment. Indeed, much of the success of the Gossamer projects has been attributed to the extraordinary bank of talent that Paul MacCready was able to draw on. There is probably no place in the world where one can recruit so many versatile and highly skilled people in the relevant fields on such short notice as California.

The enlarged crew speeded up the pace of building tremendously. Replacement wing ribs were made for those damaged in the *Albatross*'s last crash. The etch tank was kept busy continuously; it had to be cooled with a garden hose when a fresh batch of acid was added, and it slurped and gurgled as if it was harboring a small dragon.

Toward the end of February, the problem of sticking control lines was solved at last. Ernie Franzgrote, a chemical engineer at the Jet Propulsion Laboratory, persuaded three of his colleagues, all mechanical engineers, to redesign the control-line pulleys for the *Gossamer Albatross*. The Delrin and aluminum version they came up with weighed only 4.5 grams and the lines slid through it like silk. "Perfect pulley finally!" Paul exulted in his notebook.

The *Gossamer Albatross* made only a few short test flights during March, and one led to another crash, this time because of a genuine error. Despite the tightened safety program, one flying wire end fitting, about the size and shape of a paper clip, had been missed when the plane was checked over. The fitting opened in flight, the wire slipped off its anchor on the outboard starboard wing spar, and the spar broke. The right wing folded up, crumpling the leading edge and three ribs. The fuselage frame and one propeller blade were also broken when the plane

hit the runway. This time, however, there were no injuries, and repairs proceeded apace.

Optimizing the Propeller

Through much of this period, Paul felt that the propeller needed improvement. On April 2, while it was being repaired, he mentioned his disenchantment with it at a soaring symposium, where he was referred to Professor Eugene Larrabee, an aerodynamicist at the Massachusetts Insitute of Technology who had directed several student human-powered flight projects. Larrabee offered to have his students design a computer-optimized cruise propeller for the *Gossamer Albatross*. Paul accepted the offer gratefully, and during the next week three M.I.T. students, Hyong Bang, Bob Parks, and Harold Youngren, stayed up nights to run some 150 solutions of an algorithm for propeller chord and twist. Their computer time was donated by the M.I.T. Student Information Processing Board. The most promising blade shape they arrived at was 88 percent efficient, and the specifications for it and 30 other related designs were hand-carried to California within a few days.

In the meantime, though there was still no evidence that the *Gossamer Albatross* could cross San Pedro Harbor, let alone the English Channel, Paul was worrying about getting the plane to England. The airline freight price was $38,000, which stimulated a search for free transportation. But alternatives disappeared one by one as various team members called their erstwhile aerospace employers and friends without results. Boeing's reaction was typical. They listened interestedly when told that the parts were large enough to fill much of the hold of a 747 freighter. Then they asked how much the shipment weighed. "Well, about 200 pounds." There was a long pause. "You mean the whole load weighs the same as *one passenger*?" The rest of the call, including much nervous laughter, was used mostly to establish the sobriety of the caller.

In Tune with the Universe

Finally, however, things began to move in a way that made the team feel that the *Albatross* was in tune with the universe; it was like those occasional early days when the *Condor* would suddenly get up on the step. They learned that the Royal Air Force was sending a Lockheed C-130 *Hercules* transport to Nellis Air Force Base in Nevada on May 10 that would probably have room to take the *Gossamer* aircraft back to England — free. And the *Albatross* was promptly repaired and ready to fly again.

At this stage a skeletonized two-way radio with a push-to-talk switch for the pilot was installed. The added weight of the radio had been anticipated, but the plane was also getting heavier each time a spar was spliced or a frame tube replaced. It is doubtful that the *Gossamer Albatross* maintained its design weight of 55 pounds for more than a few days during its youth. By the time it reached England it was a middle-aged airplane, and like many middle-aged individuals, it had gained significant weight.

During one of the tuneups in England, all the plane's instruments were weighed. Here is the avionics package of the *Gossamer Albatross*:

Two-way radio and instrument electronics: 320.3 grams
Airspeed and altitude meters: 210.8 grams
Airspeed transducer: 39.7 grams
Acoustic altitude transducer: 48.2 grams
Cables and connectors: 56.7 grams
Total weight: 675.7 grams

The *Gossamer Albatross* had also decreased in size. The redesign of the wing into four detachable sections shortened the span from the original 96 feet to 93 feet 10 inches.

Bring on Daedalus: I'll Whop Him!

On the morning of April 6, the plane is airworthy again, the sky is grey-white, and the air feels heavy and cold. The wind is veering from north to northwest at about 6 miles per hour. The *Albatross* wing sections were eased out of the trailer one by one. After 15 minutes of coaxing, Bryan is finally persuaded to give up his sleeping bag. It takes a little over an hour to rig the plane; Bryan is taped into the cockpit and makes a 25-second flight to check the controls. He begins the second flight low; there is a touch at 49 seconds, and a second one at 1 minute and 55 seconds. Then the *Albatross* spreads its wings at last: Bryan pedals for 7 minutes and 5 seconds more, for a total flight time of 9 minutes.

The crew is elated. How did it go? everyone wants to know. Not too bad, Allen reports. The cockpit is fogged inside, and both of Bryan's wrists are tired because they have been flexed backward during the

flight. We have him hold his hands where they are comfortable and note that the control axis should be rotated forward 30 degrees. He has a red welt on his left palm; the gusset on the pitch-control handle will have to be padded. "What about the power?" Sam asks. "About a third [horsepower] on the average, but maybe six-tenths in strong sink." Allen isn't breathing hard, but the *Albatross*'s power band is far too high for a really long flight.

Then on April 14, after some additional tuning and the installation of a new optical airspeed sensor and a lightweight dual cockpit instrument that displayed both speed and altitude, Bryan flew the *Albatross* for 15 minutes and 45 seconds, covering a distance of 3.2 miles. It was a new world record, but the flight revealed more problems than it solved.

First of all, Bryan was worn out when he landed. The flying power was far higher than the 0.25 horsepower predicted by tow tests and flights the previous summer, and it was certainly too high for a Channel flight. The controls had also deteriorated, turns were mushy, and Bryan reported the "climb response very poor, not like it used to be." The drive chain kept slipping off the sprockets, and the cockpit ventilation was so inadequate that Bryan could barely see through the fogged window when he landed. (He transpires about one litre of moisture per hour during hard pedaling.) Despite these difficulties, there were a few long stretches where Bryan reported that the "cruise power seems OK."

The crew went to work on the more obvious problems. Larger air vents with adjustable flaps

The diamond solitaire.

A rare gift.

One single diamond.
Set simply and elegantly, to sparkle on its own.
The diamond solitaire.
A jewel that becomes more precious with
every passing year.
The gift that makes a rare and beautiful
moment last a lifetime.

A diamond is forever.

The ¼ carat diamond shown is enlarged for detail. DeBeers.

were cut in the front and rear of the cockpit, and a long tube was installed to carry the pilot's exhalations out the rear of the fuselage. The new speedometer/altimeter was calibrated, and the turn and warp controls were rebalanced. But the critical problem of power seemed elusive: there were clues — those mysterious stretches where the plane flew so smoothly and easily — but the design team did not recognize the magnitude of the obstacle, turbulence drag, until months later, after the problem had been surmounted by persistence and good luck.

On April 21 at 5:30 A.M., Bryan Allen took off in still air, determined to log a flight that the team would consider "long." Sam Durán, following the plane on a moped, noted that the left wingtip was fluttering, and that the wing gap covers and propeller blades were wrinkling in flight. Bryan's time was 18 minutes, 38 seconds; it was a record again, but he was exhausted.

The team had now learned that the RAF transport would be at Nellis Air Force Base on April 27 — less than one week away. It was obvious that the offer of free shipment would be wasted if the longest flight that the *Albatross* could make was 18 minutes.

The team's response was almost instinctive by now: tighten up everything. They went over the plane piece by piece, lightening, streamlining, sealing gaps, and tightening the Mylar. During the recent flight tests, the construction crew had been working on the new Kevlar-skinned propeller built to the M.I.T. specifications. Now the new propeller was sanded and polished, ready to be fitted to the plane. With its slim, tapered gray blades, it looked more potent and less toylike than the transparent yellow and orange paddles that had moved the *Condor* and the *Albatross* up to now.

On April 25 at 4 A.M., the *Albatross* was once more assembled at what had become a small camp on Harper Dry Lake. Erection took an hour and a half, and every part and connection was checked twice. At 5:48 Bryan took off in calm air and immediately reported that the cruise power felt very low; he estimated it as 0.28 to 0.3 horsepower. The propeller turned smoothly at a steady 97 revolutions per minute, and the plane settled into a groove at an altitude of nine feet. The crew's moped gave out after a few minutes, and the *Albatross* was followed across the desert by a van at 10 miles per hour.

By 6:13 the team was aware that the *Gossamer Albatross* was on the step as no human-powered aircraft had ever been before. The fuselage was slightly bulged, pressurized by the warm air inside. Over the radio Bryan was asked how he was doing. "Bring on Daedalus. I'll whop him," was the cocky answer.

Allen was flying in a large triangle, and as the plane floated along, crew members had time to make subtle and detailed observations of the airplane's parts. More small changes were logged in this one flight than in the twenty that preceded it.

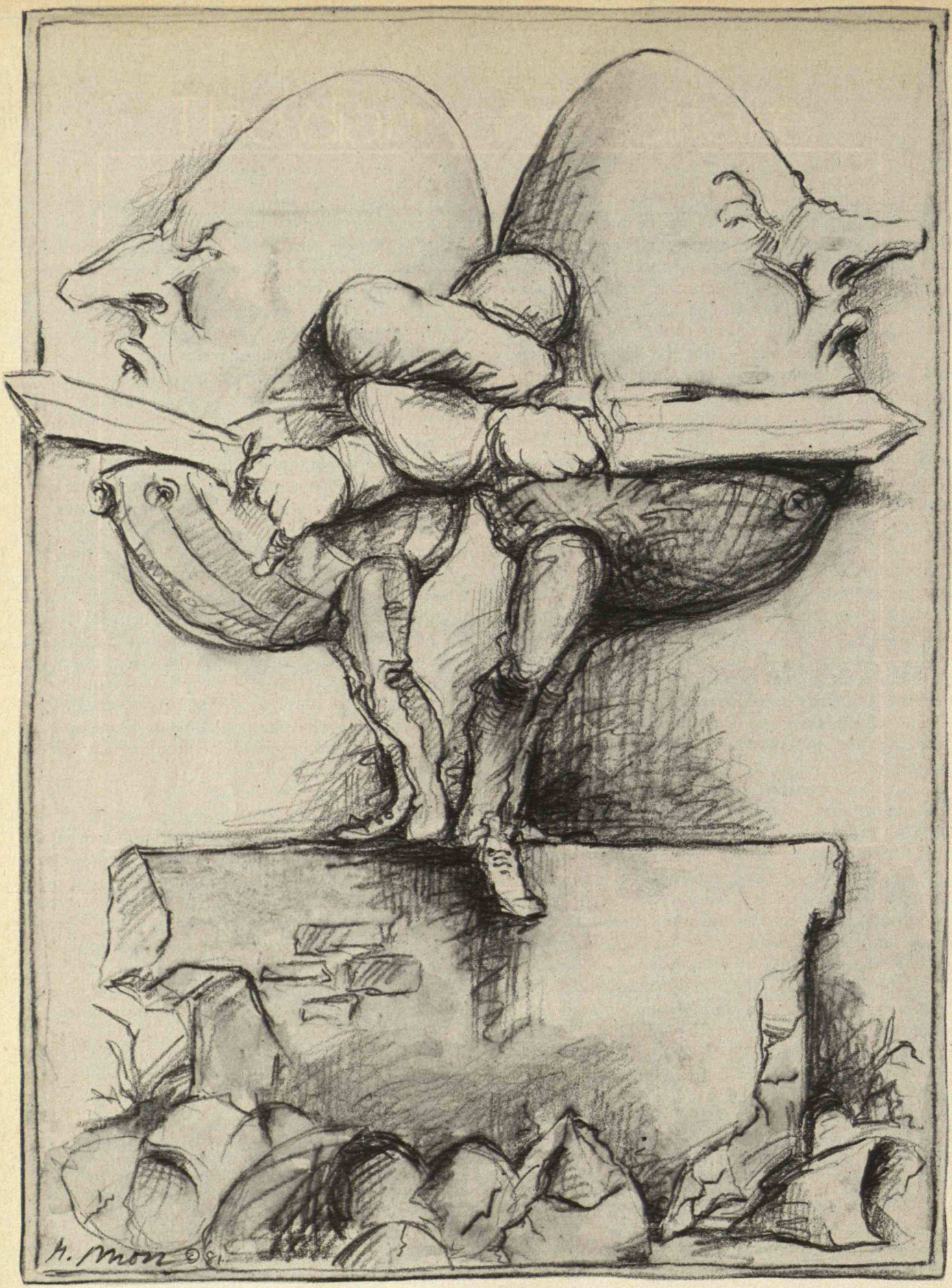
Bryan pedaled on tirelessly; at 30 minutes he reported that sweat had begun to run into his eyes. Shortly thereafter he heard a popping noise, and noted that the wing warp guide had broken, which caused a slight mushiness in the controls. Sweat burning his eyes was still the major discomfort, although his left hand was beginning to ache from the pressure of the pitch control and the seat had started to overheat. At 40 minutes a slight headwind came up, and Allen made a 180-degree turn to run downwind. Ten minutes later both his glasses and the bottom of the fuselage were beginning to fog despite the improved ventilation. At 58 minutes the temperature inside the cockpit had risen from 60° to 71° F. Bryan made a right turn and then another sweeping 180-degree turn that took 47 seconds to complete. At 6:56 he announced that he was hungry and thirsty and starting to land.

When the *Gossamer Albatross* touched down, it had flown 1 hour, 9 minutes, and 3 seconds — by a tremendous margin the longest time that a man had ever supported himself in the air solely with his own power. Bryan was far from exhausted, and he was sure that with food and water he could have flown another 1 to 2 hours.

As soon as the crew reached a telephone, news of the long flight was spread to the rest of the *Gossamer* team members, together with the word we had been waiting for: the Channel expedition was go.

This article is the first of two excerpts from *Gossamer Odyssey*. Next month: *Gossamer Albatross* conquers the Channel.

Morton Grosser was a member of the *Gossamer Albatross* team. After studying engineering at M.I.T. (S.B, 1953; S.M., 1954), Dr. Grosser did research in biology at M.I.T. in electromechanical materials and in control systems at Raytheon Corp. and Clevite Corp. Later he took his Ph.D. in the history of science at Stanford (1961) and turned to writing and consulting as a career. This article is condensed from his book *Gossamer Odyssey: The Triumph of Human-Powered Flight*, to be published in May by Houghton-Mifflin Co. Printed with permission.



Illustrations: Geoffrey Moss/Washington Post

To Gain a Peace in the Nuclear Age

by Roger Fisher

The danger was neither his fault nor his responsibility. But it was his job to do something about it.

WHEN I spoke at a conference on the medical consequences of nuclear war last fall, several colleagues commented on my place at the end of the program. After two days on the horrors of nuclear Armageddon, I was supposed, in 45 minutes, to tell everyone how to prevent it. A typical remark was, "Boy, have *you* got a problem!"

Whenever I hear that phrase I am reminded of a small incident that occurred during World War II, when I was a B-17 weather reconnaissance officer. On one particularly fine day we were in Newfoundland test-flying a new engine. Our pilot was only a flight officer because he had been court-martialed so frequently for his wild activities, but he was highly skillful. He took us up to about 14,000 feet and then, to give the new engine a rigorous test, he stopped the other three and feathered their propellers into the wind. We flew along on one engine for a few minutes — it is rather impressive to see what a B-17 can do on one engine. It cannot quite hold its altitude, but if it is light, it can do quite well. Then, just for a lark, the pilot feathered the fourth propeller and turned off the engine.

That was startling. Suddenly the sound was gone. With all four propellers stationary, we glided, somewhat like a stone, toward the rocks and forests of Newfoundland. After a minute or so, the pilot pushed the button to unfeather. At this point he remembered that to unfeather the propeller, you had to have electric power, and to have electric power you had to have at least one engine going. As we were strapping on our parachutes, the copilot burst out laughing. Turning to the pilot he said, "Boy oh boy, have *you* got a problem!"

Though we're all in this together — like the crew of that B-17 — I sense a tendency among professionals to put the problem of preventing nuclear war on someone else's agenda. But whoever is responsible for creating the danger, we're all on board one fragile spacecraft. We have no choice — we are here together and the risk is high. What can we do to reduce it?

We Have Met the Enemy

The risk is high for two kinds of reasons — hardware reasons and people reasons. We spend a lot of time thinking about the hardware. Both arms-control advocates and the military tend to focus on nuclear explosives and the means for their delivery. We think about the terrible numbers of terrible weapons, counting them by the hundreds, by the thousands, and by the tens of thousands. There are clearly too many, and there are too many fingers on the trigger.

Yes, changes should be made in the hardware. We

should stop, I believe, all production of nuclear weapons and cut back on what we have. But even if we succeeded in stopping production and bringing about significant reductions, there would still be thousands of nuclear weapons for a long time. We, like the military, keep our attention on the hardware. They think it is the answer; we think it is the problem. It is not, however, the most serious part of the problem.

The U.S. Air Force and the U.S. Navy have a great many nuclear weapons. Each has enough weapons to blow the other up, and certainly they have disagreements — anyone who has stepped inside the Pentagon knows there are serious disputes between the air force and the navy. Disputes that mean jobs, careers — disputes that are sometimes more serious in practical consequences than disputes between the United States and the Soviet Union. Yet there is little risk of war between our air force and our navy. They have learned to conduct their disputes differently. They fight them out before the Senate Appropriations Committee and the Secretary of Defense, in the White House, and on the football field.

The case of the navy and the air force demonstrates, crudely, that the problem is not just in the hardware — the problem is in our own minds, in the way we think about nuclear weapons and in our working assumptions. And if the problem lies in the way we think, then that's where the answer lies. In Pogo's immortal phrase, "We have met the enemy and they are us."

Dangerous Assumptions

The danger of nuclear war is so great primarily because of the mental box we put ourselves in. We all have working assumptions that usually remain unexamined, and it is these assumptions that make the world so dangerous. Three that are particularly relevant concern our ultimate goals, the means for pursuing those ends, and finally, whose job it is to do what.

First, about our objectives. Internationally (as well as nationally and politically), we think we want to "win." Two stories illustrate that point. In England about 15 years ago, my son and I were playing catch with a Frisbee in Hyde Park. Some Englishmen, who had apparently never seen a Frisbee, stopped to watch. Finally, one came over to me and said, "Sorry to bother you. Been watching you a quarter of an hour. Who's winning?" I wish I had been quick enough to ask him if he were married and if so, "Who's winning?"

The second story is about a time when I *was* trying to win. In the late 1950s I spent two years in the Solicitor General's Office arguing cases for the government in the Supreme Court. I started off with an excellent batting average — eight wins and no losses — which made me really impossible to put up with. Oscar Davis, who was then first assistant, put me in my place with some gibe which I naturally have forgotten. But he then said something I have always remembered. He said, "You know, we don't want to win them all." I said, "Excuse me?" He said, "Did you ever think what would happen if the government of the United States won all the cases in the Supreme Court? Prosecutors would run amok, respect for the Court would disappear, the whole concept of government under law would be destroyed — it would be a disaster." I said, "But Oscar, what am I doing up there? I put on my striped trousers and my morning coat, I go up, I argue. What is the purpose?" "Oh," he said, "we want to win each case, but not every case."

Internationally and domestically, we want a system in which we can play to win, but not in which any one side — even our own — wins all the time. But this concept of "winning" — that there is such a thing and that it is our dominant objective — is one of our fundamental beliefs. In fact, like a poker player, we have three kinds of objectives. One is to win the hand. Whatever we think we want, we want it now. We want victory. The second objective is to be in a good position for future hands. We want a reputation and chips on the table so that we can influence future events. We want power. Our third objective is not to have the table kicked over or the house burned down while we are playing. We want peace.

We want victory, we want power, and we want peace. And exploding nuclear weapons will not help us achieve any one of them. We have to reexamine rigorously our working assumption that in a future war we would want to "win." What do we mean by "win"?

The Meaning of Success

Last year, I taught some exercises in Rome for the NATO Defense College. I gave the officers a

The problem is not just in the hardware; the problem is in our minds.

hypothetical war in Europe and asked them to work out NATO's war aims. The war was presumed to have grown out of a general strike in East Germany, with Soviet and West German tanks fighting on both sides of the border. Deterrence had failed. I told the NATO officers in Rome, "You are in charge of the hotline message to Moscow. What is the purpose of this war? What are you trying to do?" At first they thought they knew — win! Very simple. But what did that mean?

As time passed, they realized that NATO did not plan to conquer the Soviet Union acre by acre as the Allies conquered Germany in World War II — they did not plan physically to impose their will on the Soviet Union. They were seeking a Soviet decision; that was the only way they could have a successful outcome.

With further thought they reached a second conclusion — they were not going to ask for unconditional surrender. That gave the NATO officers a simple task: just define the Soviet decision that would constitute success for NATO and that NATO could reasonably expect the Soviet Union to make. They worked through the day considering how the Russians saw their choice.

It turned out that the only plausible objective was to stop the war. "Winning" meant ending the war on acceptable terms. It was with difficulty and even pain that some officers discovered that winning meant stopping, even if there were some Soviet troops in West Germany and only a promise to restore the *status quo ante*.

They found it hard to draft a fair cease-fire that didn't sound like a unilateral NATO ultimatum. It might say, "Stop firing at 0100 hours tomorrow, promise to withdraw, promise to restore the status quo within 48 hours, and we then will meet in Vienna to talk about serious problems." But the NATO officers did not know whether the Soviets would prefer Geneva to Vienna or whether they wanted 0200 hours rather than 0100 hours, and so forth.

Someone creatively suggested, "Wouldn't it be a good idea if we worked out ahead of time with the Russians some cease-fire drafts that we can both accept?" Another officer was incredulous: "What did you say? You are going to negotiate the armistice before the war begins? In that case, why have the war?" Good question.

The need to reexamine our assumptions about the purpose of our foreign policy is also demonstrated by our self-centered definition of national security. Typically, political leaders suggest that the first priority of foreign policy is national security, and only after that has been taken care of should we worry about our relations with the Soviet Union and China. Such thinking assumes that somehow we can be safe while the Soviet Union faces a high risk of nuclear war. But in any nuclear war with them, missiles will go both ways. There is no way we can make the world more dangerous for them without also making it more dangerous for ourselves. The less secure the Soviets feel, the more they will do something about it. Security is a joint problem.

We should say, "Look, you Russians have got to understand why we build these missiles and how it looks to us when you behave as you do. You must take responsibility for helping us deal with our security problem." Similarly, we must take responsibility for dealing with their security problem.

I may point out that those of us who say such things frequently do not practice what we preach. I am always prepared to tell my friends at the Pentagon that it does no good to call the Soviets idiots. "Don't you see, you idiot?" I say. We in the peace movement frequently think our job is to "win" the war against hawks. In worrying about our interests,

we often assume that our adversaries have none worth considering. That's wrong. We have to find out what their legitimate concerns are, and we have to solve their legitimate interests in order to solve our own. At every level, domestically and internationally, we need to reexamine our objectives. We are not seeking to win a war but to gain a peace.

Plutonium Security Blanket

A second set of dangerous assumptions are those we make about means — about how to pursue our objectives. Again, we and the rest of the world are caught up in a military way of thinking.

The basic mistaken assumption is that for every problem there is a military solution. We will first try diplomacy, but if that doesn't solve the problem, we assume that we can always use force. We recognize that military means may cost a lot. But most of us believe that if we have the courage and are prepared to pay the price, then we can always solve the problem by military means. The reality, however, is that the big problems in today's world have no military solution. Nuclear war is not a solution — it is worse than any problem it might "solve."

We have mislearned from the past. During World War II, the Allies could physically impose a result on Hitler acre by acre. But the world has changed; we can no longer physically impose results on any nuclear nation. Except for imposing modest results in small situations, the only means we have is to try to change somebody's mind. There is no way we can make the world work by using nuclear bombs, and yet people put that in the back of their minds. "Yes, that's true," they say, and then they go right ahead operating on the assumption that there are military solutions.

Like Linus in the Charlie Brown comic strip, we cling to our security blanket, military hardware. Both.American and Soviet officials clutch their blankets as though they offered real security. Somehow, we think this bomb, this hardware, will protect us and let us avoid dealing with the real world.

Seeing Things as the Other Side Sees Them

We all know far better ways to deal with international problems: Break up big problems into manageable pieces. Look at each item on its merits. Sit down with the other side and discuss it. Don't concentrate on what people say their positions are but try to understand and deal with their interests. Communicate and, particularly, *listen*. What's bothering them? Before we can change their minds, we have to put ourselves in their shoes. How would we feel?

If you were sitting in Moscow and saw Japan thinking of rearming; if you saw your long-time strongest ally, China, with a 2000-mile common frontier, now becoming your worst enemy; if you saw Pakistan apparently building a nuclear bomb; if you heard Western voices saying, "We must help the rebels in Afghanistan"; if you saw American military equipment in the Persian Gulf, in Saudi Arabia, in Egypt, and in Israel; if you saw Greece going back into NATO and Turkey in the hands of a military government; and if cruise missiles were about to be located in West Germany — how must all that look from Moscow? Is there any reason for the Russians to be a little concerned? The only way we can reduce the threat of war is to affect their future thinking, and the starting point is to understand their present thinking.

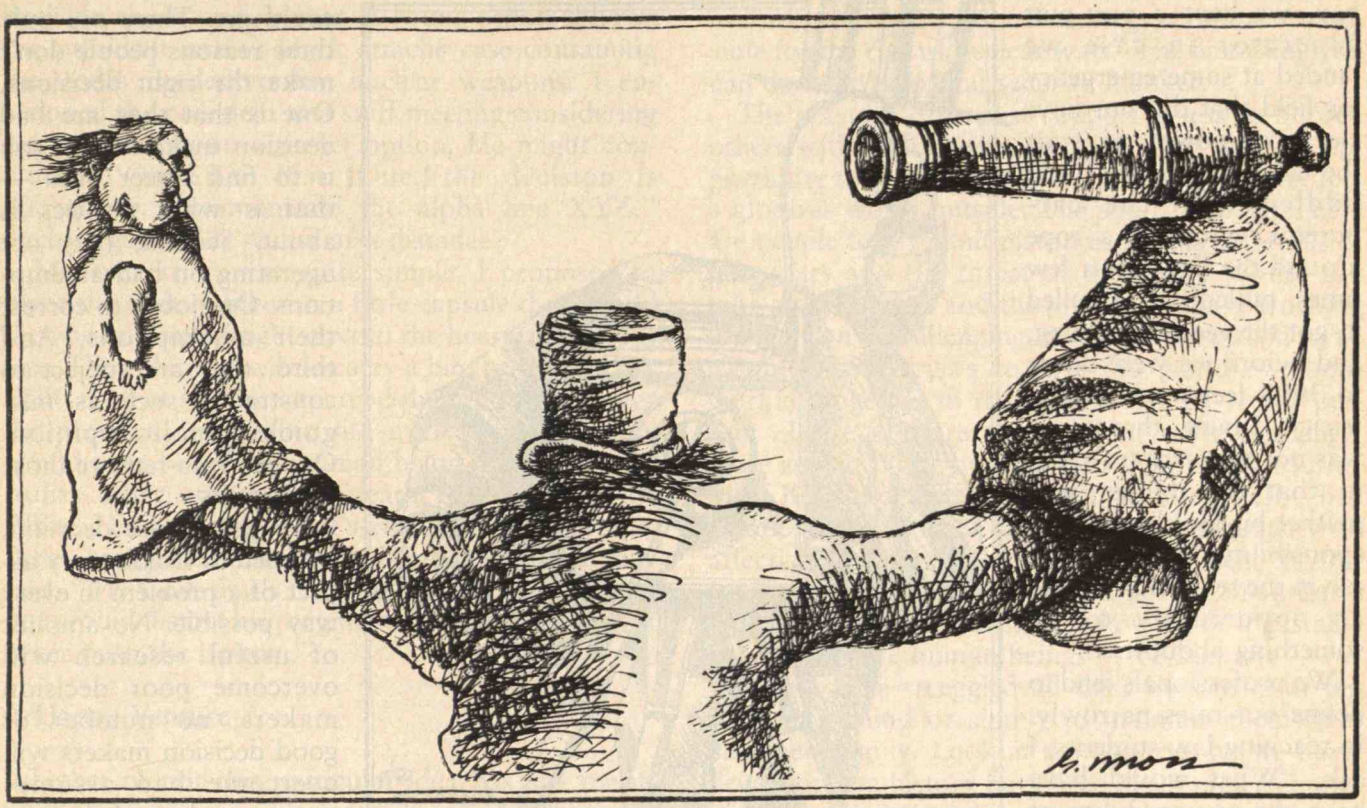
Second, we have to invent wise solutions, find good ways to reconcile our differing interests. And both sides must participate in that process. It's not possible in any conflict for one side to produce the right answer. The understanding that comes from working jointly on a problem, and the acceptability that comes from participating in creating a solution, both make any answer better.

We will want to insist on principles in the problem-solving process — objective criteria independent of their will and ours. The best method cannot be to insist, "We're more stubborn than you." That way lies chaos, that way lies Armageddon. We can be firm on principle and flexible in application, and at every point, participation, participation, participation.

That same process applies equally to our domestic differences. Again, we in the peace movement are not the only source of wisdom — we are part of the conflict. There are a lot of people in this country who have legitimate concerns about the Soviet Union. We have got to put ourselves in their shoes — Pentagon shoes. We should not insist on inventing all the answers ourselves. We must try to participate with them, not carry on a war.

We will need to promote joint problem solving, not just at the intellectual level but at the level of

**If ever
the president wanted to fire nuclear weapons,
it would have to be by killing
one human being
personally.**



feeling, the level of emotion, the level of caring, the level of concern. International conflict is too often dealt with cerebrally, as though it were a hypothetical problem. We need to apply what we know, and even more, to keep on learning about human behavior. We want to understand how to affect it — not merely to manipulate it, but to realign the forces within us to work in a better direction.

Whose Job Is It?

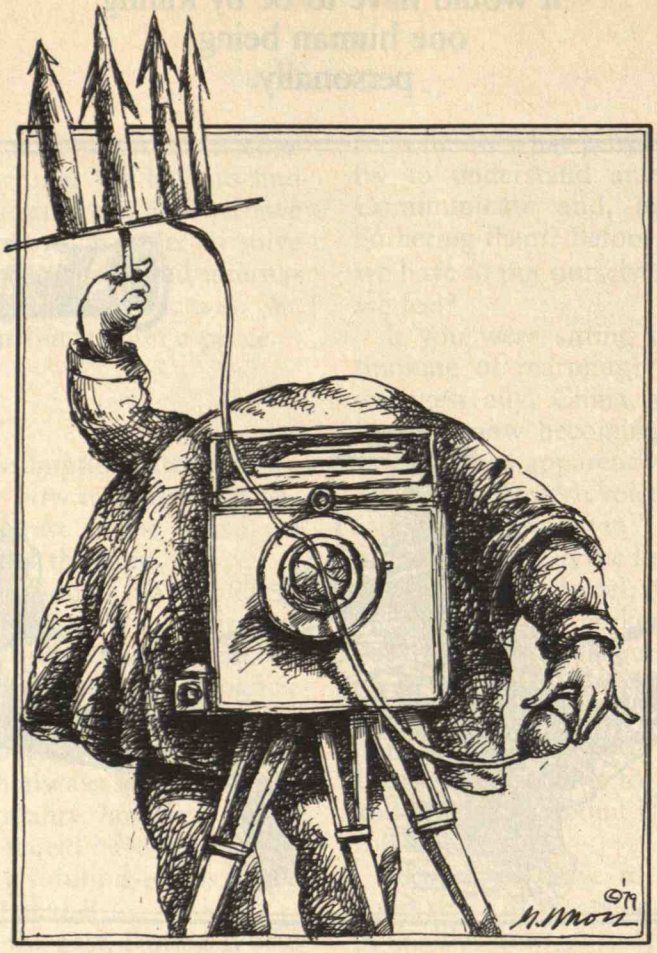
The danger of nuclear war also comes from my third set of assumptions — about whose job it is to reduce the risk of war. If there were a military solution, there would be a case for leaving it to the military, to policy-science experts and professional strategists. At the meeting last fall on the consequences of nuclear war, doctors were saying, in effect, "We are just concerned with the medical aspects. We will limit ourselves to the area of our professional expertise. We will tell you how bad a nuclear war would be. It is somebody else's job to prevent it." Such statements rest on the assumption that preventing war is in the military hardware department. But we are not facing a technical military problem. The solution lies within each of us, in changing our assumptions — and in changing other people's assumptions. The solution lies in reaching maturity, in abandoning our plutonium security blanket.

We are dealing with a set of psychological problems with dangerous physical consequences. If people are clinging to a plutonium blanket that is bad for their health, you do not get an engineer to design a better blanket — the problem is within those who are clinging to it.

No one has a professional license in reducing the risk of nuclear war. Fortunately, however, no professional license is required. But who has the skills to deal with psychological problems such as denial and turning flesh-and-blood issues into jargon-laden abstractions? Who is likely to notice that people are denying responsibility because a problem seems too overwhelming? Weapons engineers? I think not.

A little while ago I left you in a B-17 over the hills of Newfoundland — our copilot was telling the pilot that *he* had a problem. Well, we didn't crash; we weren't all killed. On that plane we had a buck sergeant who remembered that behind the bomb

bay, we kept a putt-putt generator in case we landed at some emergency air field that did not have electrical power to start the engines. He ran back, fiddled with the carburetor, wrapped a rope around the flywheel a few times, pulled it and pulled it, got the generator going, and before we were down to 3000 feet we had electricity. Saving that plane was not the sergeant's job, in that the danger was neither his fault nor his responsibility. But it *was* his job in the sense that he had an opportunity to do something about it.



We professionals tend to define our roles narrowly. In teaching law students, I ask, "What would have been the responsibility of professional musicians hearing Nero's performance on the fiddle while Rome burned? Should they limit themselves to discussing the music?" A citizen's response would presumably be to get a bucket and help put out the fire. By becoming professionals, do we become less responsible? Can we say, "No, I'm a professional, not a firefighter. It's someone else's job to put out the fire."

Our special knowledge and training may not obligate us to try to prevent nuclear war, but it does give us an opportunity. My notion of who has responsibility for something is best defined by who has the opportunity — we have the opportunity. I encourage you, as I encourage myself, to use it. The world is at risk. The very danger of nuclear war means that there is more opportunity for each of us to make a difference than ever before in human history.

A Professional's Responsibility

What are some of these opportunities? If everyone with any significant power made the right decision every time, that would be as close to utopia as we could get. There are only three reasons people don't make the right decisions. One is that they are bad decision makers. Our job is to find better ones — that is what politics is about. Second, they are operating on bad assumptions. Our job is to correct their assumptions. And third, they are subject to constraints such as misguided public opinion. Our job is to remove those constraints.

To get a wise decision, we need to tackle every aspect of a problem in every way possible. No amount of useful research will overcome poor decision makers, no number of good decision makers will overcome bad assumptions or harmful constraints. Somebody has to propose a solution. Somebody has to put it on a decision maker's agenda. Somebody has to persuade others that it is a good idea, and somebody has to carry out the idea. There is enough to keep us all busy.

We need hard facts. We need theories on how to reduce instability. We need to develop knowledge about nuclear war, about the consequences, and about ways to reduce those risks. We need to communicate that knowledge, both to the public, which constrains our decision makers, and to the people who are making important decisions. We need to communicate both the bad news and opportunities for reducing it. When we deliver bad news and then say there is nothing to be done about it, the bad news does not become operational. The bad news about nuclear war will not by itself reduce the risk of nuclear war; we have to act on that news.

Blood on the White House Carpet

My earliest arms-control proposal dealt with the president's remoteness from reality when facing a

**We cannot insist,
"We're more stubborn than you."
That way lies
Armageddon.**

decision about nuclear war. A young officer follows the president with a black attaché case containing the codes needed to fire nuclear weapons. I envisioned the president at a staff meeting considering nuclear war as an abstract option. He might conclude, "On SIOP Plan One, the decision is affirmative. Communicate the alpha line XYZ." Such jargon holds reality at a distance.

My suggestion was quite simple. I proposed to place the code number in a little capsule that would then be implanted right next to the heart of a volunteer. The volunteer would carry a big, heavy butcher knife as he or she accompanied the president. If ever the president wanted to fire nuclear weapons, he would have to kill one human being personally and realize what an innocent death is. Blood on the White House carpet — it's reality brought home. When I suggested this to friends in the Pentagon they said, "My God, that's terrible. Having to kill someone would distort his judgment. The president might never push the button."

A Happy Venture

Whether or not this particular idea has any merit, a lot of action is required to educate the public. A common lament is, "I don't know what to do." That gives you something to do right there. Get a half-dozen friends together some Saturday morning and figure out some things you might do. Identify three or four other people whom you think could make decisions of some significance. What are some of these decisions? Why haven't they made them already? What can be done to increase the chance they'll make a desired decision next week? Whoever it is — journalists, people in government, business people, civic organizations, professional societies, a friend of President Reagan's — what are some things they might do that would illuminate our faulty working assumptions or help establish better ones? More time should be spent on aiming than on implementation. In intellectual efforts, as in gunnery, one's aim is crucial.

Don't wait to be instructed — take charge. This is not an organized campaign that someone else is going to run. If you share these concerns, get involved — there is a lot to do. Perhaps you are still holding onto your own security blanket, that nice professional definition of your job. The security blanket most of us cling to is, "Don't blame me. It's not my job to plan nuclear strategy. I'm not responsible for the risk of nuclear war." The first thing you can do is give up that security blanket.

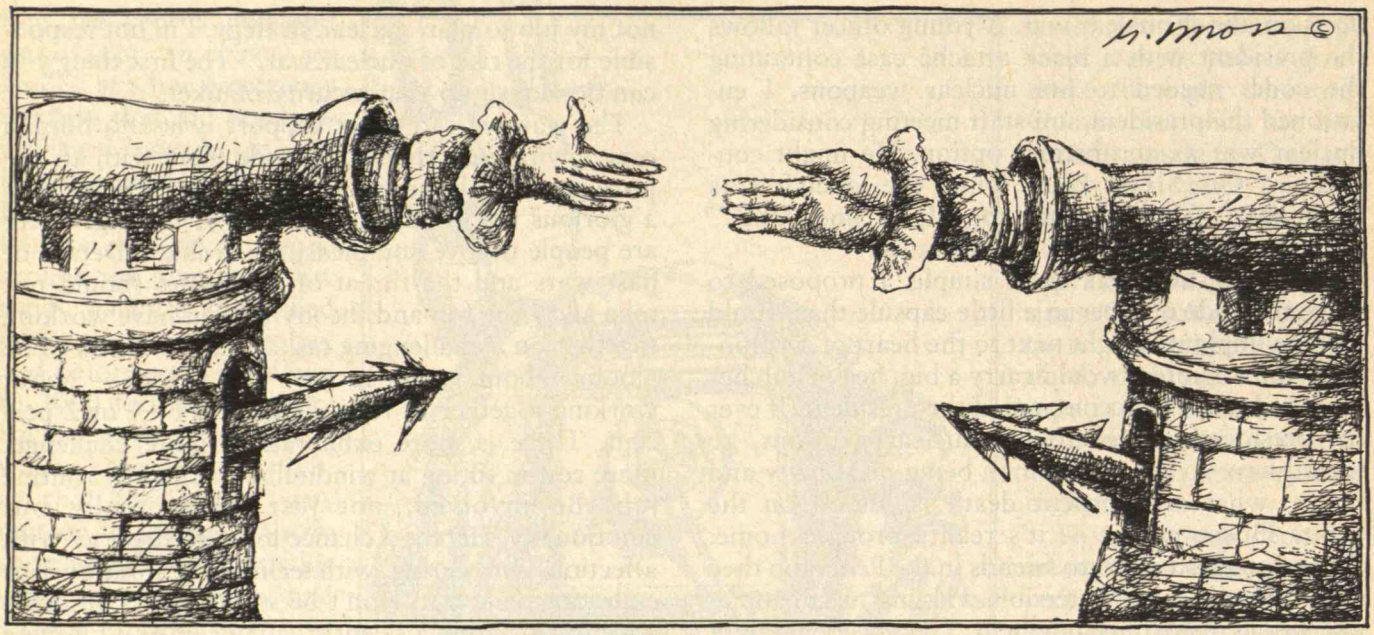
The way we can enlist support is less to burden others with guilt than to provide them with an opportunity to volunteer. I find it a happy venture. It is a glorious world outside. The sun is shining. There are people to love and pleasures to share. Details of past wars and the threat of the future should not take away the fun and the joy we can have working together on a challenging task. I see no reason to be gloomy about trying to save the world — about working together to reduce that risk by 1 or 2 percent. There is more exhilaration, more challenge, more zest in tilting at windmills than in any routine job. Be involved, not just intellectually but emotionally. Here is a chance to work together with affection, with caring, with feeling. Let some of your emotions hang out. Don't be so uptight. You don't have to be simply a scientist, a lawyer, or a business person. We are human beings — be human.

People have struggled all their lives to clear ten acres of ground or simply to maintain themselves and their family. Look at the opportunity we have. Few people in history have been given such a chance to apply their convictions, their values, their highest moral goals with such competence as our professional skills may give us. A chance to work with others — to have the satisfaction that comes from playing a role, however small, in a constructive enterprise. It's not compulsory; so much the better. But what challenge could be greater? We have an opportunity to improve the chance of human survival.

Roger Fisher is Williston Professor of Law at Harvard University and director of the Harvard Negotiation Project. This article is adapted from his remarks at a conference on "The Medical Consequences of Nuclear War" sponsored by the Physicians for Social Responsibility and the Council for a Livable World, held last November in San Francisco. A similar version appeared in the March 1981 issue of the *Bulletin of the Atomic Scientists*.

Arms-Control Negotiations in a Cold Climate

by Paul C. Warnke



THE current vogue in foreign policy analysis is to attribute most international problems to American weakness and irresolution. The United States, we are told, is losing its position of world leadership because of its failure to stand up against the inexorable march of Soviet power. In this view, détente and arms control have been overemphasized, encouraging the Soviets to move into Afghanistan, threaten Poland, and, through political subversion, create unrest and instability in the Third World. The ascendancy of this view —which has been given a major boost by Soviet brandishing of military might — has stalled the SALT process and caused a virtual breakdown of communication between the two superpowers.

But this outlook has failed to assure our national security in an age when nuclear weapons on both sides can bring about mutual devastation in well under an hour. Some would have us pursue a policy of overall confrontation buttressed by unrestrained buildup of strategic nuclear and conventional military strength. At the other extreme are the hardy few who oppose any effort to match Soviet military strength and would have us rely instead on the moral force of our good example.

Living with the Soviets

Neither extreme has much to recommend it. The best hope for survival lies in pursuing a policy not very different from the one that Republican as well as Democratic administrations have been following for quite a few years. As always, the implementation of that policy can be improved. Certainly it has not been helped by the dissonant multiplicity of voices purporting to enunciate official policy. But we would be wrong to conclude that because of it, the Soviets have acquired an overall advantage in military power and are now emerging as the dominant political force in the world.

I don't believe this is happening. The problems of the Russians, both at home and abroad, dwarf those of the United States and its friends, and only an exaggerated view of Soviet power and a naive confidence in the uses of military force can put us in a position of inferiority. The fact that the Soviets are in Afghanistan is their fault, not ours. And their behavior there and elsewhere is a sign of weakness, not strength. If we were to imitate it, we would forfeit the edge that we continue to have and should preserve.

Beyond question, present American-Soviet relations are poor indeed. We should not overlook the dangers created by this acrimony. But it's a mistake to assume that we have no areas of common interest or that one superpower can improve its security at the expense of the other's security.

For those to whom a steady Cold War climate brings more comfort than the temperature variations of détente, Soviet behavior demonstrates that détente is a myth, that arms control is a failure, and that those who hope for any agreements with the Soviets are hapless dupes. To them, the answer is to regain strategic nuclear superiority by outspending the Soviets in an all-out arms race. This prescription would mean a long wait, a large bill, and less security.

Recognizing the Soviets' combination of sophisticated military power and primitive politics, I can't claim to be totally objective about how we should deal with them. However, I am convinced that a policy that accepts unrestrained military competition as inevitable is a policy of despair. At a minimum, we will find ourselves straining our resources, unable to meet our domestic commitments, under even heavier inflationary pressures, and contorting our foreign policy away from efforts at sound international development. At worst, we and the Soviets

will destroy one another.

One of the problems in dealing with the Russians is our ingrained tendency to classify people and countries as good or bad. When the Soviet Union misbehaves abroad and denies its citizens the right to dissent or even to leave, our instinctive reaction is to have nothing to do with them.

But the real question for the next decade is not whether we and the Russians will be friends; that's too remote a prospect to consider. The question instead is whether, despite our many and serious differences, we can build on the few areas of common interest to promote our own security and international stability. We don't have to like the Soviets, but we do have to live with them. No effective foreign policy can progress by treating U.S.-Soviet relations as an issue for debate between the hard-liners and the soft-liners. What counts here is the bottom line, and the bottom line is coexistence or no existence.

Common Interests

The first area of common interest is national survival. Anyone who has spent time in the Soviet Union or dealt with Soviet officials can't help but be aware of the deep feeling Russians have for their country. It can be seen even in the attitudes of Soviet dissidents who have defected or been exiled.

I am convinced that the Soviets are genuinely interested in completing a strategic-arms-limitation treaty. This is the only explanation for the major Soviet moves to accommodate American positions, beginning with the Vladivostok understanding in 1974 and continuing through the SALT II negotiations, where they accepted the full U.S. position on verification.

My own experience is that the Soviet leaders recognize that deterrence, through fear that nuclear war means mutual assured destruction ("MAD"), is not an abstract theory but an inescapable fact of life. However, some people conclude that the Soviets proceed on the belief that a nuclear war can in fact be fought, survived, and won. Such views are indeed to be found in Soviet military articles, just as they have appeared for years in American publications. According to this view, we should emphasize strategic nuclear weapons as arms with which to fight a limited nuclear war instead of as a deterrent. The new Presidential Directive 59 has been touted by some as a dramatic shift to a strategy of targeting for a controlled, protracted nuclear war from which we can emerge safe, sound, and victorious. If this is correct, the new strategy is a change from MAD to worse.

No nuclear war can consist of surgical strikes in which only the weapons systems on both sides suffer the major casualties. Any counterforce attack, intended to destroy the other side's land-based missiles, strategic bombers, and in-port missile submarines, must involve launching thousands of nuclear warheads and killing tens of millions of people. Former Secretary of Defense Harold Brown has said that command and control facilities would be stressed in our new targeting plans; neither Washington nor Moscow would be a privileged sanctuary. The result would be something more than a temporary dip in the rate of national growth; we'd both be former superpowers — unwept, unhonored, and unsung.

Another area of common interest between the United States and the Soviet Union is nonproliferation. The possible spread of nuclear weapons is a matter of great concern to the Soviets. Looking at the other nuclear-weapons states — the United Kingdom, France, and the People's Republic of China — they see themselves as target number one. It is significant that in the comprehensive test-ban talks, which began in 1977, Soviet negotiators have accepted a ban on peaceful nuclear explosions, a system for on-site inspections, and the principle of national stations on Soviet and U.S. territory to monitor seismic events and distinguish earthquakes from underground explosions.

The Soviet leaders recognize, as we should, that a complete ban on nuclear test explosions would powerfully inhibit more countries from acquiring nuclear-weapons capability. Provisions for on-site inspection must have shocked the guardians of Soviet security. Yet these have been accepted as part of the price of a test-ban treaty.

Moreover, the Soviet leadership has to be as concerned as we are about avoiding any real military conflict. This is not altruism but a recognition of the serious problems they now face, which would be greatly aggravated in the event of armed conflict with the West. The strains that any protracted war would impose on the Soviet empire could well be strains that it could not withstand.

Unquestionably, Soviet military planners would have to worry about the reliability of the non-Soviet components of the Warsaw Pact. Polish troops, like those of Hungary and Czechoslovakia, would have little enthusiasm for spilling their own blood to preserve Soviet hegemony. Moreover, within the Soviet Union itself, almost half of the population is non-Russian — and proud of it. And looming across the Eastern border, the Chinese continue to regard the Russians with implacable hostility and age-old resentment.

Of course, we can only speculate on the factors the Politburo considered in deciding to intervene in Afghanistan. Almost certainly, the Soviet leadership balanced the risks of standing by while an anti-Soviet government took power there against the risks of further straining relations with the West and the Third World. Following the first course would have risked a militantly Islamic regime in a neighboring country whose people have ethnic and religious ties to a rapidly growing part of the Soviet population. And it may be that the stalling of SALT and the less-than-subtle playing of America's China card bolstered the argument that little could be lost in further alienating the West. In trying to forestall Soviet armed intervention in Poland, we might keep in mind that a well-stocked diplomatic bag includes a few carrots as well as sticks.

An Absolute Priority

It's a mistake to think Soviet influence is waxing while ours is waning. The Soviets have major influence in no more than a small fraction of the world's countries, most of them minor players on the world stage. And even among that fraction, they'd be hard put to find a true friend.

But there are those who attribute all U.S. international troubles to what they call our

post-Vietnam trauma. Indeed, they show every sign of nostalgia for the troubling and divisive days of our misguided intervention in Indochina. In their analysis, U.S. military force is the cure for all the world's ills. But Iraq and Iran are at war today for reasons unrelated to the American-Soviet competition. Attempts to blame such regional conflicts on failures of U.S. foreign policy or gaps in our defense are the residue of the myth that we're responsible for everything that goes on in the world.

Dealing with Soviet military power requires, in the first instance, a strong and flexible U.S. military posture. This can best be achieved by improving our conventional military force. The situation won't be helped by reviving the B-1 bomber, which was already becoming obsolete when I left the Pentagon over a decade ago. Nor will we have the funds to improve our conventional force if we waste $60 to $100 billion on a luxury housing project for 200 MX missiles. Our deficiencies are in training, maintaining, and retaining skilled people, not in esoteric technology and unusable nuclear weapons.

The Soviet leadership must understand that threatening the vital interests of the United States would be counterproductive and inimical to true Soviet security. The Kremlin is aware that under the NATO charter, an attack on Western Europe would be treated as an attack on the United States. This represents no challenge to their security and no provocation. The U.S. government has tried to make it clear that the use of Soviet military force to control the Persian Gulf nations would similarly be regarded as an assault on our vital interests.

The same people who believe in a military cure-all also advocate "linkage" in its most extreme form — not only refusing trade relations with the Soviets but foregoing arms-control negotiations until they clean up their act. This is not a promising way to contain the Soviet military threat.

It is inimical to our security interests to use the SALT process itself as a bargaining chip, for without effective arms control, both sides will almost surely go ahead with developments that will bring the nightmare of nuclear war closer to reality. Regrettably, we cannot expect the present Soviet government to act consistently as a good international citizen. But if we suspend or slow down SALT negotiations every time the Soviet Union takes an action of which we disapprove, the inevitable frictions will take on a dimension of risk that is insupportable and unnecessary. As Andrei Sakharov eloquently put it, "The danger of annihilating humanity in a nuclear war carries an absolute priority over all other considerations."

Keeping out of the Fire

The only logical linkage between SALT and détente is that success in SALT may bring improvements in the overall superpower relationship. Certainly we have seen the converse, in which the stalling of SALT has been accompanied by serious deterioration of U.S.-Soviet relations, and I doubt that this is only coincidence. Nor is there any logical linkage between the problem of Soviet military power and the world's other security problems. Unrest and disorderly change in the Third World, precipitated by poverty and disease and ignorance and injustice, would exist if there had never been a Soviet Union.

The Soviets may well be eager to exploit a chaotic local condition. But to counter Soviet influence, we need not and should not fight, bleed, and die to prevent changes in the geopolitical status quo. Counting on our military force to protect all our international interests would create unrest at home, win us the hostility of the developing countries, and muffle their growing criticism of Soviet aggression.

In many developing countries, there is a swelling dissatisfaction with a status quo that has meant luxury for a few and misery for the many. The governments of some of these countries advertise themselves as resolutely pro-American and anti-Communist. Some voices in the United States insist that we should support our long-time friends, even if they are "moderately repressive," regardless of the wishes of the people in those countries.

We should strive instead for international condemnation of all military intervention. Perhaps it is not surprising that those in the U.S. who most loudly condemn Soviet military intervention in Afghanistan simultaneously lament our own failure to intervene on behalf of the shah in Iran and General Somoza in Nicaragua. But we can't have it both ways. Either we follow a policy of nonintervention or we help create an ever more dangerous, unproductive, and inhumane area of superpower competition. Likewise, world peace will be further endangered if the Soviets continue to seek perfect security at the expense of other countries' rights to determine their own destinies.

Coming in from the Cold

Détente, I must hope, has a future. Soviet actions in the face of the Polish workers' struggle for free unions and a looser rein from the government will tell us much about its prospects. Meanwhile, we must continue efforts for arms control and maintain the military posture that will offset Soviet military power. But this won't substitute for those more complex and sophisticated economic and political measures necessary to deal with the other, equally serious international security problems.

A policy toward the Third World based on military force can do nothing to solve our domestic ills — inflation, unemployment, drooping growth and productivity. These developing countries are becoming both our economic competitors and the fastest growing market for our exports. At the same time, those without oil resources have accumulated a debt of some $400 billion. Our ability to find a formula for economic cooperation will affect our future at least as much as the U.S.-Soviet military balance. So while the two superpowers indulge themselves in military posturing, the world goes on, and we run the risk of becoming, if not extinct, increasingly irrelevant.

Paul C. Warnke is former director of the U.S. Arms Control and Disarmament Agency and was chief U.S. negotiator for SALT II. He is currently a partner with Clifford and Warnke of Washington, D.C. *This article is adapted from his speech at the annual meeting of the American Association for the Advancement of Science in Toronto last January.* □

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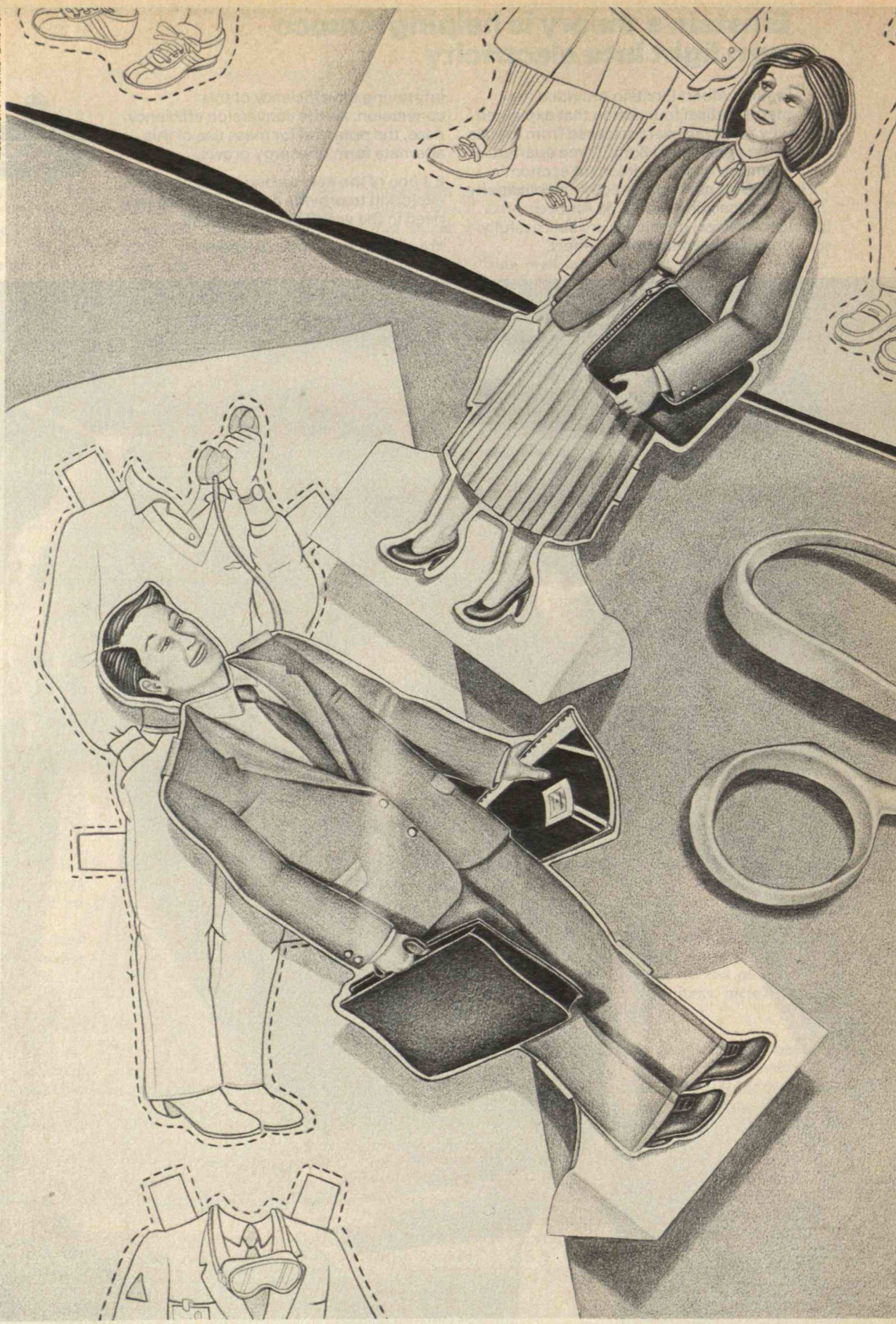
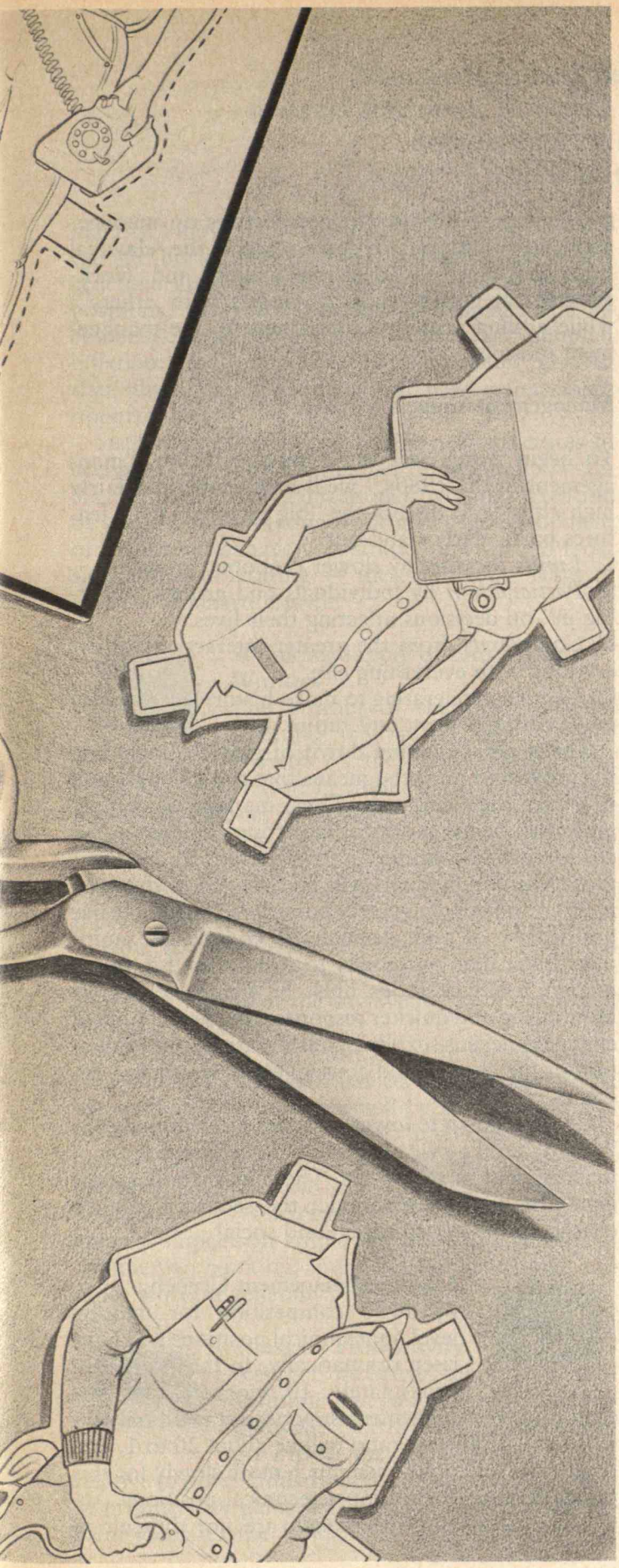


Illustrations: Michael Emerson



Management in the 1980s

by Roy Amara

New environments, new social values, and new technologies will breed a new type of manager. How will she operate?

WHAT can we predict for management in the 1980s and beyond? Of course, how a future manager operates will be profoundly influenced by economic, social, and technological changes. But there will be internally generated change as well — in the information environment and styles of decision making, for example.

Uncertainty about future influences obligates the would-be seer in any field to use caution, even when the present situation is clear. But in this case, there is uncertainty even about the *definition*: "What does a manager do?" and "how do we distinguish between good or excellent managers and poor or marginal ones?" are perennial questions even within the "management culture" itself.

If we cannot define the essential elements of a manager's job — what he or she really does that results in success or failure — how can we possibly train managers, improve decision making, design management-information systems, and make organizations more effective? Under the circumstances, the only sensible way to approach the problem is the way an airborne reconnaissance mission approaches the mapping of unfamiliar terrain: look for patterns and distinctive features from a variety of altitudes and directions.

The Management Mosaic

Many approaches have been developed to help define what a manager does. The classic textbook approach, used in one form or another for decades, might be labeled the "top-down" method. This boils down to a picture of the manager as a planner, organizer, coordinator, and decision maker. It derives in part from the "great man" anecdotal school (that probably had its greatest currency in the earlier part of this century), with its strong emphasis on leadership qualities and style. This is not a bad image of management *functions*; it simply is terribly limited, unable to convey very much about how real-world managers operate — in allocating time, for example — and how such managers view their jobs. Management issues simply do not present themselves in neat packages, requiring just "planning" or "coordinating" skills. Moreover, these purely functional categorizations smack more of how managers are perceived by others to operate or how managers think they *ought* to operate. Such idealizations are diminishingly useful and increasingly at odds with the practical world.

The so-called "work-activity" school — or the "bottom-up" approach — is at the other end of the scale in characterizing a manager's job. It is a straightforward way of getting at the question of "what does a manager really do?" that involves direct observation and the collection of information such as work records. In the last decade or two, a number of laudable efforts have been made to measure empirically the allocation of managers' time during "typical" workdays or weeks. The results of such efforts are not purported to be based on statistical measures of activity; rather, they resemble more how an anthropologist might describe the activities of an unfamiliar group or foreign culture. An example of a bottom-up insight is that the greatest percentage of a manager's time (approximately 70 percent) is devoted to face-to-face meetings. Here again, however, such particular "cuts" of management can provide only a limited glimpse.

Somewhere between these two extremes is the picture of the manager in various roles: an informational role (collecting, analyzing, and disseminating information of all kinds), a decisional role (allocating organizational resources to achieve desired objectives), and an interpersonal role (acting as employer, colleague, and representative). Again, such roles yield another set of perspectives on management, overlapping to some extent the classical functions (such as decision maker) and work-activity categories (such as "meets with others") while adding a unique component to the management mosaic.

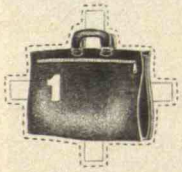
Management Shapers

To begin flying over our symbolic region, "management in the 1980s," we'll first maintain a fairly high altitude to discern the "big picture." Four features particularly stand out:

☐ *Limits* dictated by slower economic growth.
☐ *Participation* by individuals and groups "wanting in" on decisions affecting their lives.
☐ *Complexity* from the greater interactions of everything with everything else.
☐ *Change* accelerating to make history a less useful guide to the present and future.

The general slowing down of growth (including the growth of markets) means that not all boats will rise with the rising tide. Thus, managerial competence will be more critical in getting an edge on the competition. Greater participation by various groups and individuals will be reflected in the need to share power previously considered the exclusive prerogative of management. As complexity multiplies faster than our ability to comprehend it, information feedback loops must be tighter for closer monitoring and quicker response. And as the pace of change quickens, explicit consideration and evaluation of the choices and consequences (planning) becomes crucial.

Coming down to lower altitudes — examining the "micro" level — we can discern 10 major shapers of management in the 1980s. The first 5 are basically demographic and economic; the second 5 can be characterized as perceptual and social.



Middle-Management Crunch

By 1990 competition for middle-level nontechnical positions will have risen dramatically. In the 1960s approximately 10 workers vied for each middle-management supervisory position. But in the late 1980s the ratio will be about 20 to 1, and wage rates will have risen much more slowly for this group than for professional technical positions.

The reasons for the crunch are not difficult to

Management may be defined in terms of its abstract functions, its actual activities, or its role categories; none is entirely sufficient, but each adds to the mosaic.

identify: movement of the "baby-boom" group (people born between 1945 and 1965) in unprecedented numbers into candidacy for management positions; delayed retirement of management incumbents, largely in response to persistent national inflation; and generally slower economic growth that limits the development of new management opportunities.

Such circumstances cry out for new structures to accommodate the large number of potential managers. Flattening of organizational pyramids, creation of smaller, autonomous work groups, development of "working manager" positions through job redesign and restructuring — these are some ways to ease the expected crunch.

Shrinking Supply of Entry-Level Workers

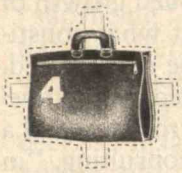
The bottom of the organizational pyramid will suffer from slower growth of the labor force. Such growth is expected to be about 1 percent per year during the eighties (compared with the 2-plus percent of the seventies). One reason is the rapid decline in fertility rates over the two decades. Another is the slowdown in the growth rate of women's entry into the labor force, owing to the drop-off in the number of women in their early twenties — traditionally the group with the highest participation rates — and the restrictive effects of the small baby boom expected during the next few years.

Because wages will inevitably rise for entry-level positions and turnover rates can be expected to be higher than normal, there will be strong incentives to substitute capital for labor. Such capital investments will clearly reshape the structure and organization of jobs as well as the related management functions. This substitution is likely to have the greatest impact on employees and management in commerce, banking, public administration, and office work in general.

Stress on Productivity

Another incentive for capital substitution for labor is productivity growth. With the productivity growth in the United States falling relative to other industrialized countries, resumption of productivity gains will become a major management focus for the 1980s.

Considerable premium will be placed on two aspects of productivity. The first is management as a catalyst — indeed, as an innovator — in spurring productivity gains, particularly in the growing service and information-handling sectors of the economy. The second is the development of new structures, roles, and practices that enhance the productivity of management itself. The redesign of the entire information environment may be crucial, and deeper understanding of "what constitutes management" could yield large payoffs.



Shifting Economies of Scale

One reason productivity gains and the definition of management are so elusive is the rapidly changing work environment. Not only are the physical environments of certain industries changing in response to rapidly escalating resource costs and technological innovation, but the regulatory and information environments are changing as well. The result is that these businesses will exhibit dramatic shifts in "economies of scale."

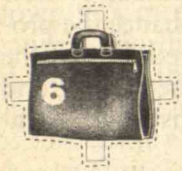
In many if not most cases, such shifts will be toward providing greater competitive advantage to the smaller, more decentralized, and more flexible organizational unit. This will be particularly true where energy is generated and utilized locally (such as in cogeneration), where prior restrictions on entry to particular markets are being lifted (such as in communication services), and where the importance of larger organizations' resources may be diminished (such as in research and development). Smaller may indeed become more beautiful.

International Competition

Another important factor governing the substitution of capital for labor in the United States is its changing competitive position with respect to other countries on a wide range of products. Such shifts are due to long-term differences in productivity growth and unit labor costs, modulated by specific trade and political measures.

Though protectionism may delay the inevitable in the early 1980s, the basic vulnerability of our low-productivity industries must ultimately be addressed. There are three choices: continued protectionism for national security or political purposes, aggressive redesign of production processes through

large capital investment, and gradual phaseout of vulnerable industries through the marketplace. Whatever policy is followed, management of human resources will emerge as a crucial factor. (*See "The Productivity Problem" by Lester C. Thurow, November/December, p. 40.*)



Redefining the Workplace

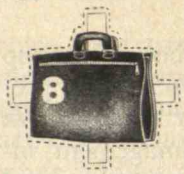
With the rapid introduction of computer-assisted communications into the office environment of the eighties and the continued growth of the information sector, our notion of what constitutes "the place of work" needs to be reexamined. Fellow workers need not be colocated, the home/office boundary need no longer be sacrosanct, and a variety of work styles — part time, consulting, "in and out" — can be accommodated.

The implications for management are many, including the need for new coordinating mechanisms, more explicit measures of work performance, and overlapping communications networks. But perhaps most important is the orchestration of face-to-face contacts that would not otherwise occur, and the development of substitutes for face-to-face contacts (such as video or computer conferencing) when personal contact is inconvenient or unnecessary.

New Communication Patterns

The revolution in the communications environment will permeate nearly all management roles. In particular, managers will find themselves in more direct contact with board members (as directors become more intimately involved in corporate affairs); they will have to learn to deal with neutral parties overseeing employee relationships; and they will interact more frequently with a variety of external groups, including representatives of the various media.

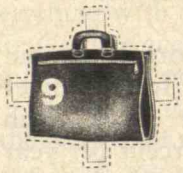
This new "fishbowl" communication environment can have a number of desirable consequences. Explicitness in decision making will have high priority. The existence of multiple networks — both "horizontal" and "vertical" — can improve organizational stability. And employee motivation may be higher because of the opportunities for greater organizational input. Managers will have to adjust the information they seek, the data they require, and their role in the communication process.



Evolving Participation

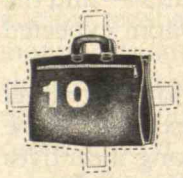
The changing patterns in information and communication are part of larger changes in the "participatory" environment. Continued skepticism about the responsiveness of large institutions, the desire for a return to a human scale in personal relationships, and the continuing search for new mediating structures by an activist generation will all provide a backdrop for increasing participation by individuals in decisions that affect their lives.

The result is a changing role for the manager, who must share decision making without abdicating responsibility for the results. Harlan Cleveland uses the phrase "steering rather than driving," others use "orchestrating" to convey the changed relationship of managers to their groups.



Diversity of Values

The focus on human resources does not end with new communication patterns and shared decision making; management must also deal with an enormous variety of values and lifestyles. For example, an increasing premium will be placed on individual competence and self-reliance. Managers in this kind of environment must focus on employee motivation, recognizing the growing importance of noneconomic rewards and individual needs.



Subjective Judgments

As the capability for collecting, analyzing, and processing "hard" data becomes more widespread, differences in the quality of choices will depend more critically on the evaluation of "soft" information. The "information level" at which managers operate will be raised, and achievement of a competitive edge will depend more heavily on their nonquantifiable skills and capabilities. Choosing objectives well, questioning assumptions, and extending the range of alternatives — both short- and long-term planning — will become the most valuable coins of the management realm.

Information, Decision Making, Women, and Wisdom in the Office

In addition to these 10 more or less irreducible shapers of management for the next decade, there

Computer-assisted communications will help transform our notion of "place of work"; the home/office boundary need no longer be sacrosanct.

are other, more speculative influences to which I suggest managers pay close attention:

The Office of the Future. Few changes in the management function will match those occurring in the information environment. Some of these are fairly apparent now, while the groundwork for others is just being laid. Perhaps most imminent are changes in our notion of "the office" — its structure, practices, and work flows. The principal driving forces are the push of powerful technologies at ever-lower costs and the pull of increasing expectations for job advancement and enrichment. The automated office will almost certainly become a reality in many American businesses in the 1980s as a host of record-keeping, accounting, report-writing, and reporting tasks are performed by networks of "intelligent" terminals, word processors, copiers, and electronic-mail systems.

The Laboratory of the Future. The revolution in the information environment will not be restricted to the office, however; other beachheads for change may appear in activities related to research and development. Here the driving forces stem from the need to stay abreast, to build a highly creative and innovative environment, and to manage complex projects more efficiently. The information can be described as technical, "hard," and quantitative, and the tools are likely to be data bases, models, and computer conferencing systems.

The Board Room of the Future. The highest potential payoffs exist in changes in the information environment of top management itself. Face-to-face communication is time-consuming and expensive, and in many instances it may not be the most effective and efficient mode of interaction. Yet there are continuing demands for face-to-face contacts and reliance on personal, "soft," qualitative inputs. A variety of interpersonal and group conferencing systems will be used to orchestrate various technological options to best match management needs.

Better Tools. One of the errors we have often made is in viewing management functions as too strictly rationalist or reductionist: collecting information, processing it in accordance with well-defined decision-making rules, evaluating alternatives, and making choices that maximize benefits at lowest cost. There is no doubt that we will have increasingly powerful tools at our disposal: decision analysis, risk analysis, interactive modeling, and simulation. And there is no doubt that at lower management levels, cadres of "business marines" will know how to apply these techniques to achieve a stated objective in the shortest, most direct line.

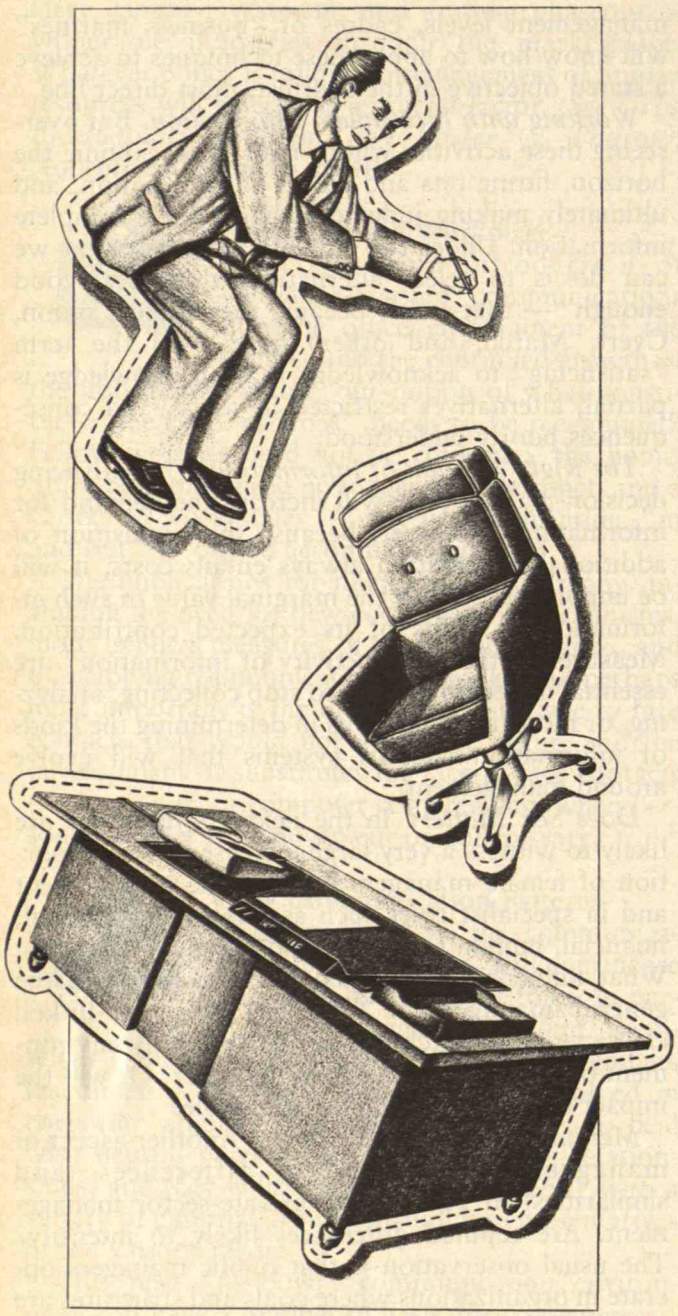
Working with Incomplete Information. But overseeing these activities will be managers scanning the horizon, fitting bits and pieces of information, and ultimately making judgments based on incomplete information. Under the circumstances, the best we can do is to select alternatives that are "good enough" — that satisfy because they suffice. Simon, Cyert, March, and others have used the term "satisficing" to acknowledge that all knowledge is partial, alternatives restricted in scope, and consequences poorly understood.

The Right Amount of Information. The satisficing decision-making style will increase the demand for information. However, because the acquisition of additional information always entails costs, it will be important to know the marginal value of such information in terms of its expected contribution. Measures of the "productivity of information" are essential in deciding when to stop collecting, analyzing, or modeling, as well as in determining the kinds of information support systems that will evolve around management.

Does Sex Matter? In the next 10 years, we are likely to witness a very large increase in the proportion of female managers both in line management and in specialist roles such as public affairs, legal, financial, human resources, and planning functions. What influence are women likely to exert on the general management function? Will sex-linked characteristics match one sex to the likely environment of the 1980s better than the other? Or will the impact of women be almost negligible?

Merging of Public and Private. Another aspect of management is related to differences (and similarities) in public- and private-sector management. Are reputed differences likely to intensify? The usual observation is that public managers operate in organizations where goals and structures are set by others, where time horizons are very short and dominated by political considerations, and where there are no clear connections to bottom-line measurements of performance. How significant will such differences be with increasing government involvement in some parts of the private sector, greater public pressure for explicit measures of accountability for government organizations, and increasing sensitivity of private-sector organizations to

The basic vulnerability of our low-productivity industries must ultimately be addressed; a crucial factor will be the management of our human resources.



"public-interest" consequences? I suspect distinctions are becoming fuzzier and that management functions in both sectors are becoming more alike.

Wisdom of the East. One of the more interesting impacts on U.S. management philosophy should be from other cultures, particularly the Japanese (or Eastern) influence. U.S. management style should not necessarily gravitate toward the Japanese model of decision making; cultural differences are too great for a direct transplant. But there is much evidence that management style is a key ingredient in the sharp productivity and quality-control gains in Japan in recent years. Such dramatic differences do not necessarily stem from the relative homogeneity of Japanese society and its associated work ethic; the same quantity and quality of gains are realized by Japanese companies that manufacture in the United States and England. This suggests that the problem lies more with management than the labor force. It also suggests the directions in which American management should evolve — toward more communication from the bottom up, more consensus in decision making, and more attention to interpersonal relationships.

Bibliography

Alter, Steven L., "How Effective Managers Use Information Systems." *Harvard Business Review,* November/December 1976, p. 97.

Bower, Joseph L., "Effective Public Management." *Harvard Business Review,* March/April 1977, p. 131.

Braybooke, D., and C.E. Lindblom, *A Strategy of Decision.* New York: Free Press, 1963.

Cleveland, Harlan, *The Future Executive.* New York: Harper and Row, 1972.

Cyert, R.M., and J.G. March, *A Behavioral Theory of the Firm.* Englewood Cliffs, N.J.: Prentice-Hall, 1963.

Johnson, Richard T., and William G. Ouchi, "Made in America." *Harvard Business Review,* September/October 1979, p. 61.

Mintzberg, Henry, *The Nature of Managerial Work.* New York: Harper and Row, 1973.

Neustadt, R.E., *Presidential Power: The Politics of Leadership.* New York: Wiley and Sons, 1960.

Pascale, Richard T., "Zen and the Art of Management." *Harvard Business Review,* March/April 1978, p. 153.

Sayles, L.R., *Managerial Behavior: Administration in Complex Organizations.* New York: McGraw-Hill, 1969.

Simon, H.A., *Administrative Behavior.* New York: Macmillan, 1957.

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Trend of Affairs

War and Peace

Tilting Toward Peace

Scientists are often blamed for the nuclear arms race; they are the ones, after all, who let the genie out of the bottle. And reversibility is assumed in the persistent, perhaps wishful belief that these very same wizards will somehow devise a way to put the genie back.

While individual members of the American Association for the Advancement of Science (AAAS) may or may not accept responsibility for either the cause or the cure, they certainly seem to agree that humanity's number-one problem — the distinct possibility of nuclear holocaust — must be a constant item on their agenda. So the annual meeting of the AAAS in Toronto this January included a

Karen Watson

variety of arms-control symposia grouped under the category "Directing Science Toward Peace."

There was earnest and detailed coverage of many subjects, but a sense of confusion, restlessness, and even futility descended upon each session. One speaker, Philip Boffey, editorial writer for the *New York Times*, isolated one of the reasons for the malaise. "In the arms-control community, all we see are the same tired old faces. . . . The media love controversy, too, but these sessions are so one-sided: peaceniks who run the political gamut from left-of-center to further left."

Mr. Boffey also offered suggestions and a useful model: the new but already powerful physicians' movement. "The issues in arms control are esoteric and unreal to most of us," he said. "They must be made more personal and meaningful in everyday terms. This is the physicans' approach — based on simple anecdotal material — and they have been able to puncture the emotions of their listeners." Other groups of specialists, despite their best ecumenical intentions, have largely continued to talk only to one another.

Anyone who has studied even a bit of science is familiar with the textbook apology that always seems to appear just when a hypothetical case begins to abut the real world: "Further discussion is beyond the scope of this text." It may be that here the problem is beyond the scope of science — or at least of science alone. And more and more scientists, even while redoubling their own arms-control efforts, are accepting the fact that the arms race, like juvenile delinquency in *West Side Story*, is a social disease. As Richard Garwin (professor of public policy at Harvard University and fellow of the IBM Research Center) told his Toronto audience: "The fault doesn't lie with the weapons designers and contractors alone. They're just doing their job. What we have is a positive feedback loop, in which Congress is responsive to the voters, who get their information from the media, who get their information from the contractors."

Better information gathering and political reform in the right places might eliminate or at least decelerate this vicious cycle. But in such a thoroughly political process, scientists can only function as responsible citizens; their scientific skills and credentials do not directly apply. They become merely another group of voters or political activists, no more or less important than any other. Although they could be instrumental in the pursuit of peace, they cannot single-handedly exorcise the evil or deliver us to the promised land.—*S.J.M.* □

Proliferation: Roots and Dimensions

"As long as the developed nations spend more than $500 billion per year on defense, the less-developed countries won't be satisfied," said William Epstein (a Canadian delegate to the United Nations and former director of the U.N.'s Disarmament Affairs Division) at the January meeting of the American Association for the Advancement of Science in Toronto. "The gap [between the developed nations and the others] will continue to widen. We cannot sustain both the arms race and aid to the developing world."

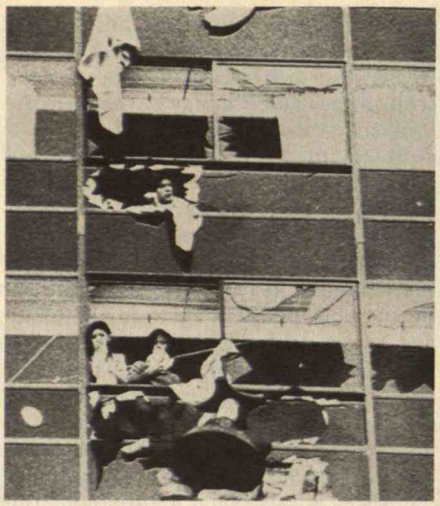
The problem is proliferation, Mr. Epstein maintained, but not only in its usual "horizontal" dimension, whereby nuclear have-nots may soon be joining the club. At issue also is "vertical" proliferation: more weapons, and more sophisticated means of delivery, for the superpowers.

"The main bulwark against the spread of nuclear weapons is the Non-Proliferation Treaty of 1968, with its 114 signatories, that imposes safeguards on the non-nuclear-weapons states," he observed. "But they are coming to view this treaty as inequitable and discriminatory because there are no comparable safeguards against vertical proliferation."

"The solution to nuclear proliferation," said George Rathjens, professor of political science at M.I.T., "lies in recognizing the motivations of other nations, in recognizing their security problems instead of putting them on a back burner." Instead of guaranteeing the security of Pakistan, for example, as a means of dissuading that nation from developing nuclear weapons, Professor Rathjens claims that we currently pursue an easier path — the cutoff of nuclear materials — that retards but doesn't stop the flow. By ignoring the security needs of such nations, he says, "we have *increased* their motivation to acquire weapons."

The possible unattractive result of continuing this strategy was briefly sketched for the audience by Lewis Dunn of the Hudson Institute. "Coldly calculating leaders may be absent," he said, from some of these countries' governments. And because they may be motivated by "mystical transcendent goals like the downfall of the 'Great Satan' United States, it may be in these conflict-prone areas that the 'nuclear peace' will break down." — *S.J.M.* □

Guests of the MGM Hotel in Las Vegas try to get fresh air (*right*) as fire (*left*) rages below in the casino area. Tragedies like this one last November could be avoided by judicious planning of escape routes, perhaps through computer modeling techniques. *(Wide World photos)*



Living

Clearing the Air

When fire broke out at the MGM Grand Hotel in Las Vegas last November, it spread with surprising speed. Flames, smoke, and toxic gases traveled so fast through the 26-story structure that several of the 84 people killed were stricken while calmly snapping photos of the inferno from their balconies. There was no way to predict the pattern of the blaze, nothing to guide residents to the safest exits or to warn them away from danger areas.

Now researchers are developing techniques that could help solve this problem. Using a variety of mathematical modeling methods, computer programs have been designed to detect and chart characteristics of fire and smoke in enclosed spaces — the first step in a process that may eventually lead to a significant reduction in this country's 8,000 annual fire deaths.

Notre Dame's Professor Kwang-Tzu Yang, a pioneer and major contributor to this effort, told *Technology Review* that computer simulations may someday provide room-by-room scenarios of a fire's predicted pathway and even suggest fire-fighting strategies and escape routes. In addition, the programs could be used by designers to help build fire-resisting capabilities into homes, hotels, airplanes, railroad cars, and other structures.

Professor Yang's latest program combines the basic characteristics of temperature, smoke concentration, and air flow with information about the specific dimensions and makeup of an area to derive a code that, in theory, can describe a fire's path. He and colleagues John Lloyd and A. Marty Kanury have so far based their work on the characteristics of empty rooms, but the influence of such things as furniture and light fixtures will be taken into account during the next step. Meanwhile, the group is also developing models to determine human survivability in various fire situations, as well as the contribution of thermal radiation to the heat-transfer process.

"When temperatures reach about 2000° F, every object in the room catches fire, regardless of the outside temperature," Professor Yang said, describing the so-called "flashover" effect. "Thermal radiation is an important mechanism for heat transport, and by figuring this missing link into our calculations, we think we've made an important contribution toward solving the fire modeling problem."

Earlier experimenters did not consider this factor because only small fires, which emit comparatively small amounts of heat, were studied. Large fires such as those in homes and other structures give off enormous quantities of thermal radiation, which can contribute to flashover, thereby making the fire's path appear erratic.

Jim Quintiere, acting head of the Fire Modeling Unit of the Center for Fire Research at the National Bureau of Standards, said in an interview that the most immediate application of Professor Yang's work would be as a tool for the better understanding of fire growth. Such models could eliminate the need for costly, full-scale tests that now involve the actual combustion of materials and structures.

"So far these models haven't been developed to the point where their application is readily obvious to the fire-protection community," he said. "But we've seen that much of the work is valid through comparisons with actual experiments, and this success is very encouraging." — *E.R.S.* □

To Control Costs, Control Technology?

New technology applied to the automation of hospital clinical laboratories substantially increased their capacity in the 1970s. But this increase was outstripped by the growing numbers of tests doctors asked the laboratories to perform. Was it a case of using new technology because it was there, or did the doctors' increased use of clinical tests — some of them facilitated by new technology — mark a more fundamental change in medical practice?

It is the latter, says Dr. Stan F. Finkelstein, a member of the Health Management Group in M.I.T.'s Sloan School of Management.

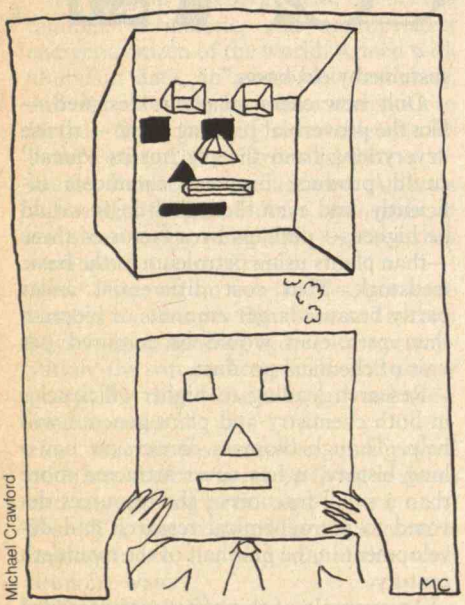
If technology were driving this growing utilization of laboratory testing, he hypothesizes, the increased testing would be in those specialties most affected by automation, where laboratory capacity increased most markedly. It was not. A survey reported by Dr. Finkelstein shows that by 1977, 98 percent of all blood-cell counters in a test sample of 204 U.S. general hospitals were automated, up from 78 percent in 1970; and hospitals using automated blood chemistry analysis increased from 65 to 95 percent. The volume of blood testing in those hospitals more than doubled in the same period. In contrast, little if any automation was brought to bear on bacteriological analysis in the 1970s. But the demand for bacteriological testing increased fastest of all.

Dr. Finkelstein believes his data challenge "the conventional wisdom that technological change (is) the definitive determinant of increased demand" in the health-care industry. Instead, there has been "a broad behavioral change . . . on the part of the physicians and others who order laboratory tests to depend more on objective measures of disease in making

diagnosis," he writes, a typical professional response to uncertainty.

And if reduced laboratory testing becomes part of a program to cut U.S. health-care costs, says Dr. Finkelstein, a simple plan to limit hospitals' capacity to perform tests is probably inappropriate. "A form of regulation that more directly addresses practitioners' behavior" may prove more useful. — *J.M.* □

The Quest for the Third Dimension



Michael Crawford

Though most of us take stereoscopic vision for granted, it turns out to be one of the most sophisticated talents of our visual system. We still do not fully understand nor can we adequately replicate the elusive sensations of visual space.

The first insights into this complicated process are credited to Sir Charles Wheatstone, best known for his electric inventions. In 1832 he found that two slightly differing two-dimensional views of a scene, as received by our separated eyes, could be merged in the brain to produce a strong impression of three-dimensionality. From this observation eventually emerged the popular Victorian stereoscope, a hand-held viewer that uses a pair of lenses to overlay the separate pictures seen by each eye.

Through the years, methods have been devised for presenting the intended information to each eye with techniques based on separate times, colors, polarizations, and directions of light. Each method has its limitations as well as advantages — the need for individual viewing devices, restricted head position, or the appearance of false colors, for example. None has fulfilled the need for unencumbered parallactic viewing (the ability to see different sides of an image as you move about it).

Enter holography, a wholly new approach to the problem. Based on Dennis Gabor's 1948 description of "wave-front reconstruction imaging," holography neatly packages into a single photographic plate all the information necessary for storing and retrieving an inherently three-dimensional image. After the invention of the laser, holography was acclaimed as the final achievement of true "imaging in the round" — the portrayal of an image with full parallax that requires no viewing devices.

Holography has struggled to live up to this early promise with many technical advances over the past 15 years. But improvements in clarity, color, and a means to produce large images are still being sought. Thus, when the Museum of Holography in New York chose to celebrate the 150-year history of three-dimensional imaging techniques in an exhibition called "Similar Visions" last year, some critics were frustrated. "Why exhibit a technology that is still so far from visual perfection?" they asked.

"It's true that many people who came to witness the state of spatial imaging, especially holography, were surprised that it is still so primitive," admits Stephen Benton, a physicist with the Polaroid Corp. and guest curator of the show. "We have become a visually sophisticated culture, after all. But most of our image communication technology is at a fairly primitive level compared to the enormous amounts of information needed to present even simple three-dimensional scenes. The problems have proven to be far more difficult than we thought even a few years ago."

Advances in wide-band satellite communications and laser-fed fiber-optic links have been very encouraging, says Dr. Benton — "Very impressive within the context for which they were intended, such as the full-color Vectographs that require cardboard spectacles. Others will have to continue to be improved." — *Suzanne Olson* □

Energy

Spin-Polarized Hydrogen

Until recently it was taken for granted that matter existed in only three states: solid, liquid, and gas. Now scientists at M.I.T. and the University of Amsterdam have produced a substance that, under certain circumstances, eludes these classifications and, in fact, is said to constitute a completely new state of matter.

Called "spin-polarized hydrogen," this artificial gas differs from its natural counterpart in two fundamental ways: it is atomic rather than molecular in structure, and the spins of its individual electrons all point in the same direction. This "polarized" spin causes the atoms to repel one another and prevents the formation of molecules, even at very low temperatures. Hence the substance never condenses into a liquid but remains a gas at essentially absolute zero — a quality that makes it unique in the observable physical world.

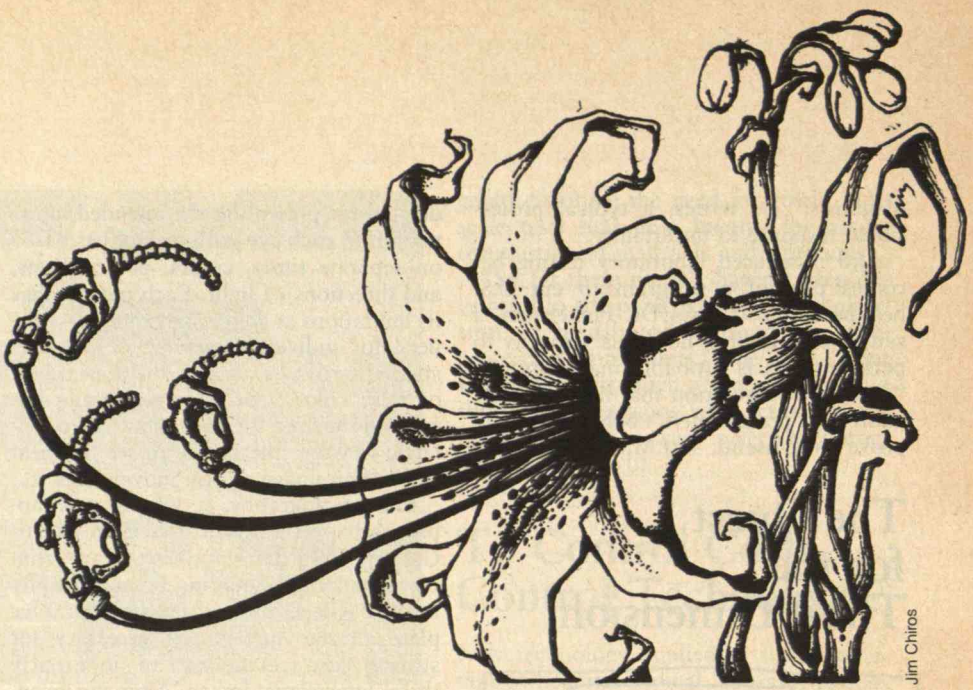
In its permanent gaseous state, spin-polarized hydrogen is so reactive that it contains the highest chemical energy by weight of any material known. In fact, M.I.T. physicists Thomas Greytak, Daniel Kleppner, and Rick Cline, who produced the largest concentrations yet achieved of the gas, estimate its energy-releasing potential to be 100 times that of dynamite. In theory, they told *Technology Review* in an interview, this enormous reactivity could be tapped and harnessed as the "world's most effective rocket fuel," or could serve as a more intense source than currently available for high-energy particle accelerators.

The M.I.T. group obtained a relatively high concentration of the gas (10^{17} atoms per cubic centimeter) by passing supercooled hydrogen through strong magnetic fields that attract atoms of like spin and then force them to maintain that spin under still lower temperatures. Energy is released when some of the electrons "flip" — reverse their spins and form molecules. Unfortunately, neither the M.I.T. group nor the University of Amsterdam team that was the first to produce the substance last year have been able to completely curtail the spontaneous flipping of electron spins. This uncontrolled behavior has so far prevented investigators from achieving high-enough concentrations of spin-polarized hydrogen to allow it to reach the

elusive superfluid level — a state never before observed in a gas. Once seen, it may open a whole new area of study.

The superfluid state is a fundamental quantum mechanical property that has been observed only in liquid helium. However, Greytak explained that liquids are relatively complex materials, and that the production of a superfluid gas would greatly enhance scientists' ability to study and understand this and other physical properties.

"We will be provided with an opportunity to look at basic properties of matter that we've never before been able to observe," Professor Kleppner said. "We have theories that describe these properties, but they have not been demonstrated experimentally. It's possible that there may be some surprises in store — that we will see things that have never been predicted." — *E.R.S.* □



Jim Chiros

Petrochemicals Without Petrol

The oldest chemical industry in America was based on biomass — naval stores, providing the colonies with turpentine and rosin from Southern pine. Since then the U.S. has relied at various times on biomass for rubber, paper, tannin, fiber, and tall oil, but feedstocks from coal before World War II and petroleum thereafter have become the standard source for most organics.

If oil runs out at some future day, could the American chemical industry rely wholly on biomass resources? It could indeed. In fact, says Professor Arthur E. Humphrey of Lehigh University's Center for Biotechnical Research, had there been no coal and oil on earth, humankind would have turned to biomass resources for most of what we now call "petrochemicals."

Cell-wall polymers, which comprise as much as 95 percent of plant material, represent "a potential resource for meeting all the chemical needs now derived from petrochemicals," Professor Irving S. Goldstein of the Department of Wood and Paper Science at North Carolina State University told the American Chemical Society last fall. Cellulose, which already yields paper, rayon, cellophane, and ingredients for plastics, is the most abundant organic material on earth — a "wonderful polymer of nature" with unusual hydrogen-bonding and strength characteristics, says Professor Humphrey.

The substitution of cellulose for petrochemicals would begin with its conversion to ethanol (a chemical feedstock as well as a fuel) and ethylene, the most important organic chemical of commerce today. Glucose made from cellulose can yield lactic acid, acetone, citric acid, and glycerine, and it can be converted into other substitutes for familiar petrochemicals. The so-called aromatic intermediates can all be derived from lignin, and other chemicals can come from the carbohydrate fraction — in contrast to the cell-wall polymers — of biomass.

Substitution of biomass for petroleum as a source for all today's petrochemicals in the United States would require about 125 million tons of wood annually, said Professor Goldstein. That's a lot; but if all of today's forest land (except parks and national forests) were turned to biomass production, 600 million tons of wood a year would be available for chemicals — far more than enough.

Professor Humphrey makes the calculation differently, but with the same result: more than 7.3×10^{14} pounds of carbon dioxide is fixed each year by plants on the planet. Some 6 percent of this — 22 billion tons per year — ends up as cellulose. If 20 percent is available for processing, that's 4 billion tons. Some 2.6 billion tons of the annual cellulose production is in the form of wood, Professor Humphrey told the American Association for the Advancement of Science early this year. He thus confirms Professor Goldstein's conclusions: there's no question that biomass could "meet all our synthetic organic material needs on a renewable sustained-yield basis."

Only new chemical plants designed — like the proverbial packing plant — to use "everything from the pig but its squeal" could produce biomass chemicals efficiently, and even then their costs would be higher — perhaps by a factor of three —than plants using petroleum as the basic feedstock. That cost differential arises partly because larger amounts of biomass than petroleum would be required per unit of chemical product.

Research leading to higher efficiencies in both chemistry and plant genetics will help. Though biomass conversion has a long history, it has never attracted more than a small fraction of the resources devoted to petrochemical research and development in the first half of the twentieth century.

An example of this effect was provided by Professor Daniel I.C. Wang of M.I.T. He reported to the AAAS that he and his colleagues have developed through genetic mutations a strain of alcohol-resistant bacteria that can convert cellulose directly to ethanol at 85 percent of the theoretical maximum yield (typical yields are about 50 percent), and they see "no technical barriers" to expanding the process from the laboratory to large-scale production.

The price of biomass resources will probably rise with the price of oil, determined by the value of biomass as an alternative to coal and oil in direct combustion. This cost is the "most imponderable" of the economic issues, said Professor Goldstein, and no one knows if or when the cost of chemicals made from petroleum will begin to exceed the cost of substitutes from biomass.— *J.M.* □

A Marriage Made in Washington

"Technology is the answer," said Amory Lovins, "but what is the question?" Speaking in a symposium at the annual meeting of the American Association for the Advancement of Science in Toronto this January, he went on to supply that question: "What is the amount, and type, and source of energy to provide what you need in the cheapest way?" For too long, he contends, our simplistic and inefficient goal has been "more energy of any kind"; it must change to "the right kind of energy for the job."

To many in the energy field, Lovins is a familiar, peripatetic, and appropriately energetic citizen of the world. Armed with abundant data, an awesome vocabulary, and the ability to sharpshoot with both to further the vision of renewable ("soft-path") energy, one Lovins is quite a resource. But now there are two. Amory's wife and colleague, Hunter, also spoke at the same symposium, and together they were quite a team. To wit:

She: "There are no free lunches, but some lunches are cheaper than others. The best buys — in descending order — are conservation, the soft path, synfuels, and power plants. But they are usually pursued in ascending order."

He: "We can free ourselves of imported oil in two direct ways: stop living in sieves and stop driving petro-pigs."

She: "The use of electricity for heating is analogous to flushing the toilet with drinking water."

The title of the symposium was itself a set of questions: "Solar Energy and Conservation: How Well Are We Doing? How Well Can We Expect to Do?" The Lovinses' implicit answers — "better than expected" and "much better," respectively — appeared to be shared by their colleagues.

Lee Schipper, a specialist in energy conservation from the Lawrence Berkeley Laboratory, agreed that gains in conservation have been impressive despite less-than-optimal political and economic conditions: "The country is now conserving energy at an equivalent rate of 4 to 5 million barrels of oil per day. Annually, this amounts to more than 10 percent of the energy used in the U.S. in 1973 (a peak year)." He forecast a "phenomenal gush" of savings as reactions to "the sock-it-to-me price increases of the last two years" come to fruition.

Dennis Hayes, director of the Solar Energy Research Institute in Boulder, Colo., expressed the hope that solar energy, aided by the Reagan administration, will also enjoy a phenomenal gush. "Unlike conventional technologies, the solar option leaves initiative and responsibility with the individual entrepreneur rather than a centralized, Washington-based bureaucracy. . . . [It is] consistent with independence and self-reliance, values this nation has held most dear."

Hayes reported that solar, like conservation, has also begun to catch on despite its relatively low federal priority, and he described modest, government-generated incentives that now exist for solar practitioners: solar tax credits, financing methods, and programs designed to support small-scale projects in electrical generation. On a larger scale, he said, the federal government requires the military to purchase approved solar-energy hardware and also helps underwrite large projects such as the Tennessee Valley Authority's ambitious solar activities.

But much more remains to be done, Hayes contended, "to counterbalance existing marketplace biases in favor of conventional sources." Although much of the action must be at the state and local levels — addressing this country's 3,000 local building codes, for example — it must all be within a "coherent federal framework." He believes that the Carter administration's goal of deriving 20 percent of the nation's energy supply from renewable sources by the year 2000 is technically feasible, and that it is politically desirable for the Reagan administration to "create a public-sector/private-sector marriage" to help achieve it.

In at least one unlikely section of the country — "the frigid northland" — marriage plans already underway may exceed the 20-percent goal. Donald E. Anderson, director of the Mid-American Solar Energy Complex (MASEC) in Minneapolis, told the AAAS symposium that by the year 2000, his 12-state region expects to produce 7 of its 27 quads of energy per year from renewable sources — and to create 240,000 jobs in the process. MASEC is one of four federally chartered regional centers charged with the commercialization and use of solar energy. "Our aim is to galvanize the building industry and make a market," Anderson said. "The technology already exists." — *S.J.M.* □

Saving Energy by Conquering Complexity

Energy-consuming systems — furnaces, engines, railroads, and factories — are inherently complex, and savings of 1 to 10 percent of U.S. energy consumption could come from a better understanding of their dynamics and control, according to a study by the American Automatic Control Council and the American Society of Mechanical Engineers (ASME).

The study identified four major areas for research in which an investment of $20 to $30 million a year could lead to annual savings of up to $10 billion.

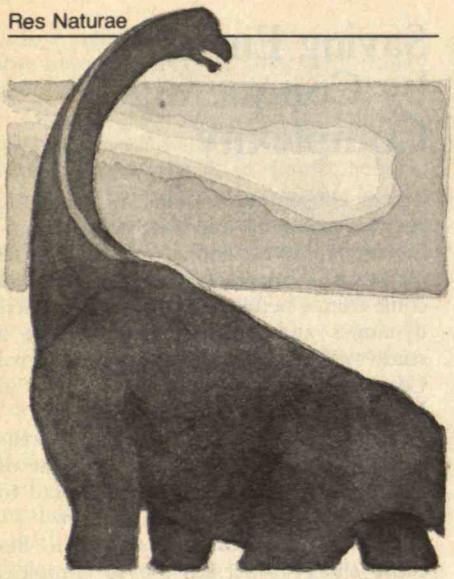
On-line optimization and control. Because energy processes are so complex, designers of equipment to control them usually oversimplify their models. Control strategies are often designed for processes with constant parameters instead of dynamic ones, and "fine-tuning" is hindered by poor methods of presenting data to the humans who devise the strategies and operate the equipment.

Improved methods for designing large-scale systems. Typical problems have to do with managing large interconnected systems, such as matching energy demands and fuel supplies, streamlining transportation networks, and integrating the purpose and design of plants and their controls into a single discipline.

Better methods of measuring and sensing system performance. Consider the management of distillation processes, which consume 3 percent of U.S. energy: new techniques of chromatography led to energy savings of 10 to 20 percent during the late 1970s. Similar opportunities are believed available in other processes and industries, especially through the application of new "smart" sensors and microelectronics.

New strategies for modeling. "Research is very much needed to improve both the theory and practice of modeling," Professor Herbert H. Richardson, head of the Department of Mechanical Engineering at M.I.T. told ASME late last year. "In addition to saving energy," he said, "the recommended research could help achieve other important goals — higher productivity of capital and labor and improved safety and reliability." Indeed, he said, the savings from these "may actually exceed" those in energy consumption.— *J.M.* □

Res Naturae



The Sky Was Falling

Virtually every species that once lived on earth is now extinct, but the question of exactly how they disappeared has long been debated among scientists. Until recently, most theories focused on a gradual evolutionary process — for example, the almost tautological suggestion that species simply became unable to cope with environmental change, or that the pressure of natural selection wiped them out.

However, according to Professor David Raup, curator and chairperson of the Department of Geology at the Field Museum of Natural History in Chicago, there is little direct evidence to support the idea that extinct species really "deserved" their fate. In fact, Professor Raup suggested at a meeting of the Council for the Advancement of Science Writing in Durham, N.C., that perhaps chance rather than fitness is the crucial factor in species viability.

By the time the dinosaurs died off some 65 million years ago, their species had enjoyed a lifespan many times that of humans. "Since more than half of all existing species were killed off at that time, it could have been pure chance that determined which ones survived," Dr. Raup said. "Animals and plants can adapt to a lot of things, but not to falling rocks."

The "rock" Professor Raup postulates is more than a metaphor. University of California physicist Louis Alvarez reported last year that he and his colleagues had found geochemical evidence that an asteroid about 10 kilometers in diameter might have struck the earth at the time of the mass extinction. Alvarez's suggestion that dust raised by the impact may have created conditions that killed off over half the world's living things has added credance to the previously unpopular "catastrophic" theory of evolution — that some species die as a result of a natural disaster. Harvard paleobiologist Stephen Jay Gould said in an interview that such a theory might help explain gaps in the fossil record, where certain species seem to die and others appear without transition.

"If an asteroid did strike, we'd have to thank it, because it is probable that if the dinosaur were still here we wouldn't be," Professor Gould quipped. "Alvarez's asteroid can't be the complete story; we know that several [animal and plant] groups were in severe decline at that time anyway. But no one else has constructed a good scenario (of evolution) either."

Professor Gould said that recent data compiled on the earth's five mass extinctions suggest that when a large percentage of all species are wiped out (such as in the Permian period 225 million years ago), some groups probably died and others survived for no biologically inherent reason. Professor Gould was careful to add, however, that he does not intend to discredit theories of natural selection, which probably account for most changes within populations, though not necessarily among populations.

Professor Raup explained that until the last decade or so, catastrophic theories have "been an anathema" to practicing scientists, and little statistical work has been done to test their feasibility. "The question is not whether evolution occurred but how it occurred," he said. "What needs to be uncovered is whether surviving species indeed represent a nonrandom sample of the biosphere that once existed." — *E.R.S.* ☐

Deadly Plants in the Desert

Some desert plants produce chemicals that are repugnant and even lethal to foraging insects. Such natural alternatives to traditional petroleum-based insecticides may be particularly useful in protecting new crops — many also indigenous to the desert — that produce hydrocarbon "feedstocks" for petroleumlike fuels.

Eloy Rodriguez, associate professor of biology at the University of California at Irvine, has studied a number of such promising insect-repelling flora. The brittle bush (*Encelia farinosa*), a member of the sunflower family that grows in the American Southwest and Mexico's Baja Peninsula, contains insect-repelling chemicals known as terpenoids. *Gerea viscida*, a close relative of the brittle bush found primarily in Baja, repels moth and butterfly larvae with chemicals produced in its glandular hair.

Other relatives of the sunflower, as well as some unrelated species, manufacture chromenes, substances that interfere with insect metamorphosis by inhibiting juvenile hormone production, says Professor Rodriguez. And some plant species, such as *Phacelia parryi* and *Phacelia ixodes* of northern Baja, kill insects outright by trapping them in sticky secretions of quinones, another group of natural insecticides.

Illustrations: Katherine Mahoney

Several approaches to using these natural pesticides are being explored:

☐ Isolating the chemicals in tissue cultures cloned from plant cells that produce the desired substances.

☐ Searching for bioregulators to stimulate cells in plants that normally do not produce the substances to do so.

☐ Breeding resistance to insects into crop plants by crossing them with related insect-repelling species.

Professor Rodriguez suggests that insecticides derived from desert plants may best be used on insects related to species sensitive to wild insect-repellant plants. "Natural insecticides probably won't have quite the general applications of petroleum-based products," he says, but they will probably degrade faster, minimizing environmental risk. — *J.K.* ☐

From Rice to Ducks, Fish, and Duck Eggs

Thai farmers with one and a half hectares of rice paddies can triple their gross incomes by converting 10 percent of the paddies to fish ponds and raising ducks in cages over them.

Waste from the ducks supports the growth of high-quality fish food in the pond. Microbial activity in the pond decomposes wastes from the ducks, liberating minerals, nutrients, and carbon dioxide, which in turn sustain algae, plankton, and bacteria — food for the fish.

By limiting the quantity of manure added to the water to minimize the danger of eutrophication — the depletion of oxygen in the water by "blooms" of bacteria and plankton — and selecting a variety of fish with appropriate eating habits, farmers can realize an annual fish harvest of about 40 to 70 kilograms per hectare — enough to supply the protein requirement of 18 adults — and farmers will still have 90 percent of their original rice yield. An added bonus: feed for the ducks can be paid for by proceeds from the sale of their eggs.

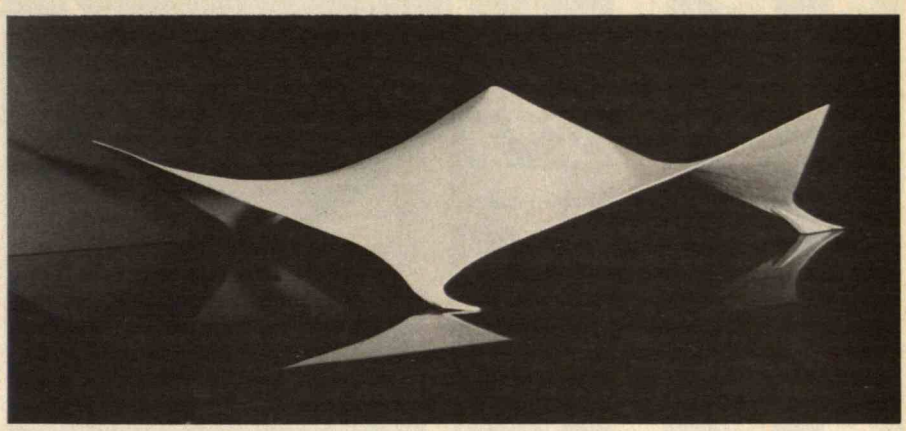
Such an aquacultural technique could alleviate food problems in many tropical and subtropical regions, according to Gerald Schroeder of the Israeli Agricultural Research Organization. The requirements of conventional fish farming can be prohibitive in such regions: each kilogram of fish represents a need for 2 to 3 kilograms (dry weight) of fish food. And animal protein commonly used in fish food, such as in fish meal, would be better used to feed people, says Dr. Schroeder.

Techniques combining livestock breeding and land use are particularly suitable for the numerous subsistence or single-crop farms in Southeast Asia. As another example, pigs that feed in part on water hyacinths are housed over fish ponds in which the hyacinths grow. Subsidies — such as from Thailand's Rural Reconstruction Movement — are often available to support this sort of land development.

On a larger scale, coastal ponds in Israel are filled with water during the rainy season, stocked with fish, and supplied with organic wastes from nearby settlements. The fish mature and are harvested at the start of the dry season, just when the nutrient-rich pond water is needed to irrigate adjacent fields.

Dr. Schroeder proposes a program that would direct sewage from coastal cities in Israel and Egypt to the fishing grounds of the Mediterranean Sea. Unfortunately, fish in polluted environments often carry parasites and undesirable bacteria, admits Dr. Schroeder, but if they are cooked thoroughly, ill effects should be minimal. It is not yet known how the salting and drying techniques used to preserve fish in these regions affect the bacteria and parasites.— *Barbara Goldoftas* □

The same emphasis on model building that led Swiss engineer Heinz Isler to develop spectacularly thin nongeometric concrete shells is reflected in this study for a roof formed by two hyperbolic paraboloids. The final structure, a residence in Geneva built in 1970, has free spans of 21 and 18 meters; the thickness of the full-scale shell is 8 centimeters. *(Photo: Leonard A. Phillips)*



Architecture

The Engineer as Artist

On a cold winter night in February 1957, a young Swiss civil engineer hung a thin cloth net over four wooden posts in his backyard and sprinkled it with water. Next morning, frozen stiff, the cloth displayed a very special nongeometric shape — neither a segment of a sphere nor a parabola and, in fact, quite mathematically inelegant.

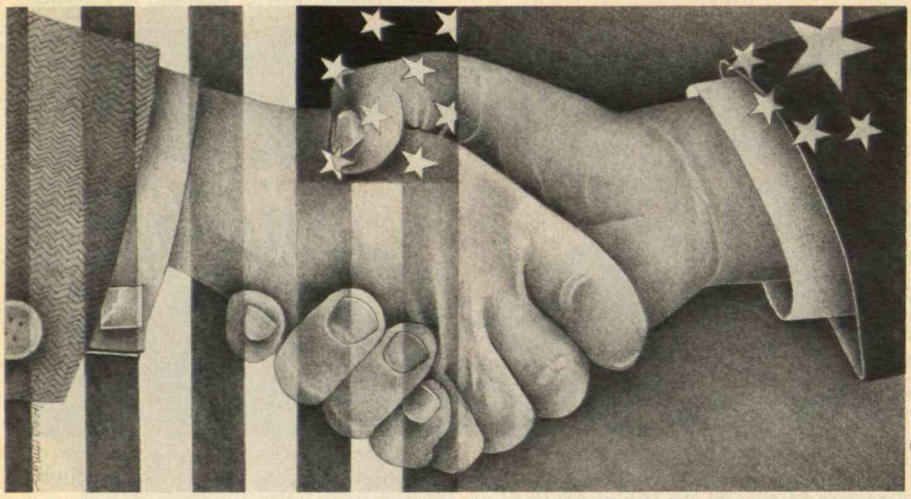
It was nonetheless a "perfect and natural shape [formed] by its own weight," wrote the engineer, Heinz Isler. Every thread was in tension. Inverted and placed on the ground on its four points, the cloth formed an ideal structural shape: it was everywhere in compression.

Isler also inflated rubber membranes as an alternative means of forming what he terms "physical analogies" of the interplay between gravity and the tensional stress of the modeling material. Experimental shapes are measured very carefully and then scaled up on the drawing board. "If there is a little mistake, it is seen immediately and then you can correct it," he explains.

On his discoveries and his ability to exploit them, Mr. Isler has built a unique career as "one of the foremost structural artists of this century," says David P. Billington, professor of civil engineering at Princeton University. Thin, delicate, beautiful, yet immensely strong concrete shells designed by Isler now grace many sites in his native Switzerland, and for beauty of line and economy of material, they put to shame the geometric forms to which Isler's imitators have mostly resorted.

Indeed, Isler shells are so strong that they far surpass Swiss building code requirements for structural rigidity: maximum deformation under "live" loads (for example, imposed by snow, wind, and people) one three-hundredth of the maximum span, a typical value for most steel structures. The *least* rigid Isler design, a factory in Recherswil, Switzerland, constructed on a 26-meter-square plan, has a deformation about one six-hundredth of its span. Two of the most rigid: an indoor tennis center at Heimberg built on a rectangular plan from four 16-by-48-meter elements and having a deformation of just under one five-thousandth; and an open shell spanning an outdoor theater in Grotzingen, having a maximum deformation of less than one four-thousandth. The bulk of his designs exhibit deformations between one one-thousandth and one two-thousandth.

The work is a triumph of aesthetics over mathematics, a technique that reaches to "the heart of structural design," writes Professor Billington in the catalog for a showing of Isler's works and methods, which he arranged for the Princeton University Art Museum last year — "the idea of an engineer, as engineer, being an artist." — *J.M.* □



Irena Roman

Business

To Enter China, Make New Friends

How should an American business make its entry into the China trade?

Slowly, with candor, patience, and modest expectations, says Professor Richard D. Robinson of the Sloan School of Management at M.I.T., after surveying 112 U.S. companies that have successfully established trade relationships with China. Other experts agree: "Developing a trade relationship with China is a long-term proposition that requires patience and perseverance," says George P. Koo of Bear Stearns China Trade Advisors.

The Chinese like to do business with "old friends" — a term that connotes a "long relationship of high quality," Dr. Koo told the American Chemical Society (ACS) last fall. Lawyers and their agreements have little place in this scene, and they aren't really needed. When the Chinese make an agreement, they live up to it.

This way of doing business puts a premium on all available forms of communication. A "technical seminar" becomes not an exposition of a product but a way of getting acquainted with its manufacturer for the Chinese. Indeed, Professor Robinson told a seminar at M.I.T. this winter, social graces play a major role in Chinese business affairs. For example, simple expressions of genuine interest in Chinese affairs are widely overlooked by U.S. corporations as a business strategy, but they can be far more effective with Chinese clients than "buying" favors with lunches and gifts.

Like all developing countries, China fears the temptations of industrial imports; the Chinese are desperately anxious to maintain their balance of trade. That's not easy: China's exports to the United States in 1978 were only $325 million (including textiles, ores, and handcrafts), and imports were valued at nearly $825 million (including agricultural products and chemicals, machinery, and synthetic fibers).

So Professor Robinson thinks the best opportunity for American firms in China is in contract manufacturing — the use of Chinese labor and skills to make products designed in the United States and eventually destined for the U.S. market. That's risky because the contract operation involves Chinese decision making, a decentralized process amalgamating the interests of government and labor in a way the Western business community can hardly understand. A U.S. company trying to protect its interests in such an environment has to depend heavily on its status as an "old friend."

Yet there is money to be made by Americans in China. Indeed, "the potential for trade with China is tremendous," Dr. Koo told the American Chemical Society's symposium on China trade last fall. But money may not be the real benefit, Professor Henry P. Sheng of California State Polytechnic University noted to the ACS. A common American-Chinese goal of "peace and prosperity through business ventures" may give priceless political and economic stability to the whole Pacific area. — *J.M.* □

Occupational Risk: A Proof-Disproof Minuet

Workers at the Rio Gland Corp. grow antlers, but the company denies any responsibility. This is a rare syndrome, it maintains, that affects only a very small number of Americans — all of whom, coincidentally, work for Rio Gland. The company is mindful of employee morale, however, so it stresses pride in this unusual, but positive, male symbol. "I've got the biggest pair in town," one worker contentedly observes.

Comedian Gabe Kaplan's fictional satire shares one important attribute with real-world occupational diseases: company officials too rarely admit the possibility that the workplace environment *may* be the culprit. Controversy — and delayed remedy — have become routine.

One such recent controversy involves brain tumors among petrochemical workers. Epidemiological studies by the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the National Cancer Institute, and the Oil, Chemical, and Atomic Workers Union (reported at a conference sponsored by the New York Academy of Science last fall) showed that deaths from brain tumors were approximately twice as common among petrochemical workers as among the general population. But similar studies by the Union Carbide, Dow Chemical, and Gulf Oil Cos. failed to show such a relationship. For example, after examining individual case histories in the "largest retrospective . . . study of refinery workers to date in North America," Dr. Chi-Pang Wen of Gulf Oil found "no increased risk of brain tumors among workers at [a] Texas refinery."

Eula Bingham, former assistant secretary of OSHA, says, "I have never been to a scientific meeting where there were not conflicting data among epidemiologists." Critics of industry-sponsored studies maintain that negative results (such as "no effect" or "no increased risk") are much less firm than positive results, especially for small populations and relatively rare phenomena. The apparent risk is reduced when studies include *all* workers regardless of their chemical exposure patterns — a common industry practice. Moreover, given the rapid proliferation of new chemicals over the past few decades, latency

periods of carcinogenic effects are often longer than the duration of the chemicals' use.

Critics of the "proworker" studies, on the other hand, claim that results are too often based on incomplete data and biased by researchers who are predisposed, as a report in *Chemical and Engineering News* put it, "to look for clues more zealously in one place than in another."

Regardless of predisposition, however, epidemiology as a method of proof — or disproof — has some serious limitations, both moral and quantitative. Shell Oil Co. recently listed four in its *Ecolibrium* magazine: "Epidemiology has four major drawbacks: first, possibilities usually can be established only after people have contracted the disease; second, the information is available only long after the causative factor has operated; third, multiple exposures on and off the job interfere with the ability to make neat cause-and-effect judgments; and fourth, epidemiology can be insensitive — effects often cannot be detected at the low levels of incidence for which industry is striving."

Proving or disproving the workplace link between brain tumors and their cause is especially inappropriate for epidemiological studies because the culpable chemical(s) is(are) unknown and correlations of effects with concentrations therefore cannot be made with confidence. But perhaps this fuzzy situation helps more than it hinders.

Given this uncertainty of cause but certainty of effect, the best approach for management is to concentrate on good housekeeping and resource-conserving, enlightened design practices — in cooperation with workers and their representatives — to virtually eliminate pollutant exposures in the workplace. Instead of the usual proof-disproof minuet, with one faction insinuating negligence and the other firmly denying it, a joint enterprise could be mutually beneficial, assuring not only the health of workers but the health of industries for which they work. — *S.J.M.* □

Right:
Since 1775, when Sir Percival Potts discovered high rates of scrotal cancer among chimney sweeps because of their exposure to soot, researchers have correlated cancers with a variety of occupational exposures to specific agents. (*Data: K. Bridbord, et al.,* Estimates of the Fraction of Cancer in the United States Related to Occupational Factors, *U.S. Department of HEW, 1978*)

Occupational groups	Cancer sites (percent excess reported)
Coal miners	Stomach (40)
Chemists	Pancreas (64) Lymphomas (79)
Foundry workers	Lung (50-150)
Textile workers	Mouth and pharynx (77)
Press operators (newspapers)	Mouth and pharynx (125)
Metal miners	Lung (200)
Coke byproduct workers	Large intestine (181) Pancreas (312)
Cadmium production workers	Lung (135) Prostate (248)
Rubber industry:	
Processing	Stomach (80) Leukemia (140)
Tire building	Bladder (88) Brain (90)
Tire curing	Lung (61)
Furniture workers	Nasal cavity and sinuses (300-400)
Shoe workers	Nasal cavity and sinuses (700)
Leather workers	Bladder (150)

Last Line

Tangible Benefits of Environmental Regulation

How much are environmental, health, and safety regulations worth?

"It is clear that the public benefits are substantial," says a research team from the M.I.T. Center for Policy Alternatives. Here is a sampling of the estimated benefits reported in more than 350 documents surveyed by the Center for the Senate Committee on Governmental Affairs last year:

□ The benefits to public health and welfare of regulating air pollution from major sources have been estimated to be worth between $4 and $58 billion annually, with automotive pollution controls alone worth $2.5 to $10 billion a year.

□ Benefits of the control of water pollution include reduced incidence of water-borne disease (worth $100 million to $1 billion a year), recreational use benefits (up to $9.4 billion a year), and "substantial increases" in the value of property near once-polluted waterways.

□ Government inspections mandated by the Occupational Safety and Health Act may have helped prevent of accidents that could have caused 40,000 to 60,000 lost workdays and up to 350 deaths both in 1974 and 1975. Regulation of the exposure of workers to asbestos alone may save 630 to 2,500 deaths per year from lung cancer and asbestosis.

□ By 1974, automotive safety standards put in place in 1966 were estimated to have saved over 28,000 lives — a 15-to-30 percent reduction in deaths and serious injuries.

□ Child-resistant drug packaging is estimated to have prevented 34,000 injuries between 1973 and 1976.

□ Crib safety standards may have reduced crib-related injuries to infants by 44 percent since 1974.

Despite such spectacular assessments of apparent regulatory success, Nicholas A. Ashford, Christopher T. Hill, and their colleagues at the Center for Policy Alternatives had reservations about their assignment. "A strict cost-benefit approach in federal regulation is not advisable," they say. There are "serious shortcomings" in the data, and they find unanswerable "philosophical and ethical issues. . . . Even [decision makers] who profess to be motivated by nonmonetary values exhibit a tendency to emphasize the quantitative. Thus, analysis itself can distort the decision-making process." — *J.M.* □

A Big Tremor in Boston?

Most Bostonians are surprised to learn that the U.S. Geological Survey considers New England at "moderate" risk of an earthquake. Indeed, 20 to 30 small tremors a year are observed on the New England Seismic Network, one of whose stations is at M.I.T.'s Wallace Geophysical Observatory in Westford, Mass.

But will there ever be a serious earthquake in Boston? Has there ever been one?

No one can answer the first question, though most experts think that Boston tremors occur when bedrock, misshaped by the weight of glaciers during the last Ice Age, resumes its original position; or perhaps they result from stresses owing to movement of our tectonic plate. Small quakes are the likely result.

To answer the second question, earthquake buffs generally refer their listeners to 1775, with tales of chimneys toppling, dishes sliding off shelves, and brick house gables fractured all the way from Boston to Cape Ann.

But maybe it wasn't so bad after all, thinks Professor Robert V. Whitman of the Department of Civil Engineering. Boston's population in 1775 was about 20,000 people living in 3,000 to 4,000 structures, one-third of which may have been made of brick, at least on the ends. The records suggest that perhaps 5 to 10 percent of Boston's chimneys came down and perhaps a dozen or two (out of 1,000) brick gable ends were damaged. Given that mortar in colonial days was not very good, those findings suggest to Professor Whitman that even this legendary New England earthquake was hardly a real rattler. □

Upholstery Afire!

Assume your chair is covered in heavy cotton duck (9.4 ounces per square yard) over polyurethane foam cushioning (with a density of 1.5 pounds per cubic foot). You drop a burning cigarette into the chair while dozing. What happens?

At the moment, no one really knows, because the sequence and timing of ignition — if it occurs — depends on a multitude of uncertainties.

For example, the temperature in the core of a burning cigarette and the time required for the cigarette to be consumed are influenced by its size and type. And the initiation and propagation of smoldering in the assembly are significantly affected by the nature and form of cushioning and by variables such as the weight, material, and presence or absence of impurities (cleanliness) in the fabric.

"Fundamental investigations of smoldering in special materials have been lacking until recently," Giuliani Tessero and her colleagues in the M.I.T. Department of Mechanical Engineering told the American Chemical Society last fall. Only exhaustive studies of different materials, assemblies, and ignition sources — the work is just beginning — can provide the technical basis for meaningful regulations and standards. □

Computers as a Lorelei for Econometric Modelers?

The growing power of computers is luring economists into ever-more-intricate models to mimic a reality that seems increasingly complex. But Professor Edwin Kuh of the Sloan School of Management sees danger in this course: economists' "intuition, judgment, and analytical tools are falling behind their capacity to build models of great size and complexity," he says.

The result is that the research community is losing confidence in models as a means for understanding complex economic interrelationships, writes Professor Kuh. To offset this trend, there is new emphasis on evaluating and improving such models in the Sloan School's Center for Computational Research in Economics and Management Science, which Professor Kuh heads. □

Quick Help for Hearts

External cardiac-assist therapy was abandoned in the 1970s in favor of an invasive technique — insertion of a balloon pump through the femoral artery in the thigh to reduce the work load on the heart. But Professors Ascher H. Shapiro and Roger D. Kamm of M.I.T. think that decision may have been premature: on the basis of detailed studies of the fluid mechanics of the human circulatory system, they conclude that an inflatable casing around the patient's legs from ankle to groin, pulsed with a wavelike, moving external pressure, will work at least as well. And it has the advantage of being available in emergencies — even in the ambulance on the way to the hospital. □

Fusion Research: Less Will Be More

We tend to underestimate the potential usefulness of magnetic fusion as a future energy technology, yet we may risk its usefulness by insisting on a "crash program" to resolve the enormous economic and technical questions that remain unanswered.

A curious dichotomy, admitted John M. Deutch, former undersecretary of the Department of Energy who is now Arthur C. Cope Professor of Chemistry at M.I.T., speaking at an M.I.T. energy symposium last fall.

Dr. Deutch's point is that magnetic fusion, which he thinks has "enormous potential" for electricity production in the twenty-first century, deserves "more serious consideration than it has received" in comparison with more conventional fossil and nuclear research and development.

But that does not mean that Dr. Deutch wants to pull out all the stops on fusion research. Quite the contrary: he fears that fusion's too-few advocates are so vocal and so anxious that the fusion research effort will move ahead too fast. Present electric-generating technologies will certainly be satisfactory for 30 to 50 years, so "there is time to do the fusion development job right" and give adequate attention to all the different concepts for making magnetic fusion work, said Dr. Deutch. He fears that our usual rhetoric "craving rapid, 'crash' programs" will lead us to "build large-scale experimental devices too quickly . . . an overinvestment in machines and concrete relative to research on the scientific and engineering base of magnetic fusion." □

Solution to February/March Crostic

What finally convinced me it was a real physical process was that the outgoing particles have a spectrum that is precisely thermal: the black hole creates and emits particles and radiation just like* an ordinary hot body with a temperature that is proportional to the surface gravity and inversely proportional to the mass.

Stephen Hawking, ("The Quantum Mechanics of) Black Holes," *Scientific American*, Jan. 1977

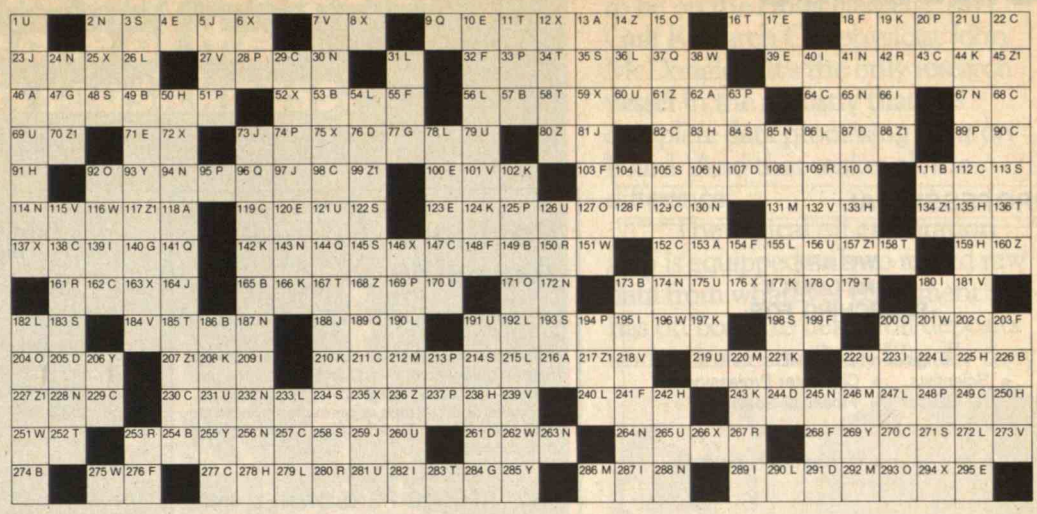
*"as if it were" in the original

A Study of Contradictions

Complete the word definitions; then enter the appropriate letters in the diagram to complete a quotation from an essay on the discovery of new physics.

The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate ends of words; if there is no black square at the right end of the diagram, the word continues on the next line.

The solution will be in the next issue, when another of Mr. Forsberg's puzzles will also appear. Readers are invited to comment—and to suggest favorite texts for future puzzles.



A Member of a branch of Islam
118 153 46 13 62 216

B Lack of firm foundation
111 173 149 186 53 254 49 165 226
57 274

C Tone poem by Richard Strauss, 1889 (3 words)
98 138 249 29 211 162 270 119 152
43 68 112 229 82 22 277 230
257 64 129 202 147 90

D Locomotive built by John Ericsson, 1829
261 76 244 205 87 107 291

E Branch of philosophy dealing with Beauty
120 295 100 10 4 71 123 39 17

F "___ will not endure" (Shakespeare, "Twelfth Night") (3 words and contr.)
55 154 148 276 128 32 18 103 199
241 268 203

G Briton or Gaul, for instance
47 284 77 140

H Dual role in Tchaikovsky's ballet "Swan Lake" (2 words)
135 133 278 159 242 91 50 225 83
250 238

I Order of butterflies and moths
195 287 289 108 209 40 139 180 66
223 282

J Material exhibiting persistent dielectric polarization
259 5 164 23 81 73 97 188

K Short story by Saki (2 words, with "The")
197 44 210 142 166 124 243 221 208
177 19 102

L German naturalist, 1769–1859 (full name)
31 86 224 233 56 279 26 190 192
78 104 54 290 155 215 240 36
272 182 247

M Norwegian polar explorer, 1861–1930
286 131 220 292 212 246

N "A hat ___" (William Cowper, "History of John Gilpin") (6 words)
41 264 24 67 106 94 30 228 187
245 263 114 143 130 232 2 174
172 288 256 85 65

O New York town, site of state prison
171 92 15 204 178 293 110 127

P Solution of $z^2y'' + zy' + (z^2 - p^2)y = 0$ (2 words)
194 74 125 63 33 169 20 248 51
95 237 28 89 213

Q Novel by John Lyly, 1578
96 200 9 189 37 144 141

R Kingdom within Republic of South Africa
150 280 267 253 42 161 109

S Russian composer, 1859–1935 (comp.)
35 122 234 193 105 3 48 214 258
198 113 271 84 183 145

T Unpleasant truth (colloq. comp.)
136 185 283 158 11 179 34 16 58
167 252

U Autobiographical work of May Sarton, 1968 (3 words)
191 21 1 231 175 69 281 121 219
60 126 265 156 260 79 170 222

V Denizen of Walt Kelly's Okefenokee (full name)
101 181 27 115 218 132 239 7 184
273

W A Département of France
151 116 196 251 275 201 262 38

X "It's a ___ to get. . ." (G&S, "Iolanthe") (3 words)
75 137 176 25 52 235 72 8 6
59 163 146 294 266 12

Y Scene of defeat of Darius, 333 B.C.
269 255 206 93 285

Z Hamitic language, descendent of ancient Egyptian
236 160 61 168 80 14

Z1 Figure of speech in which part stands for whole
99 88 217 70 134 45 207 227 157 117

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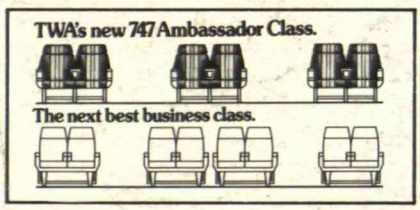

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